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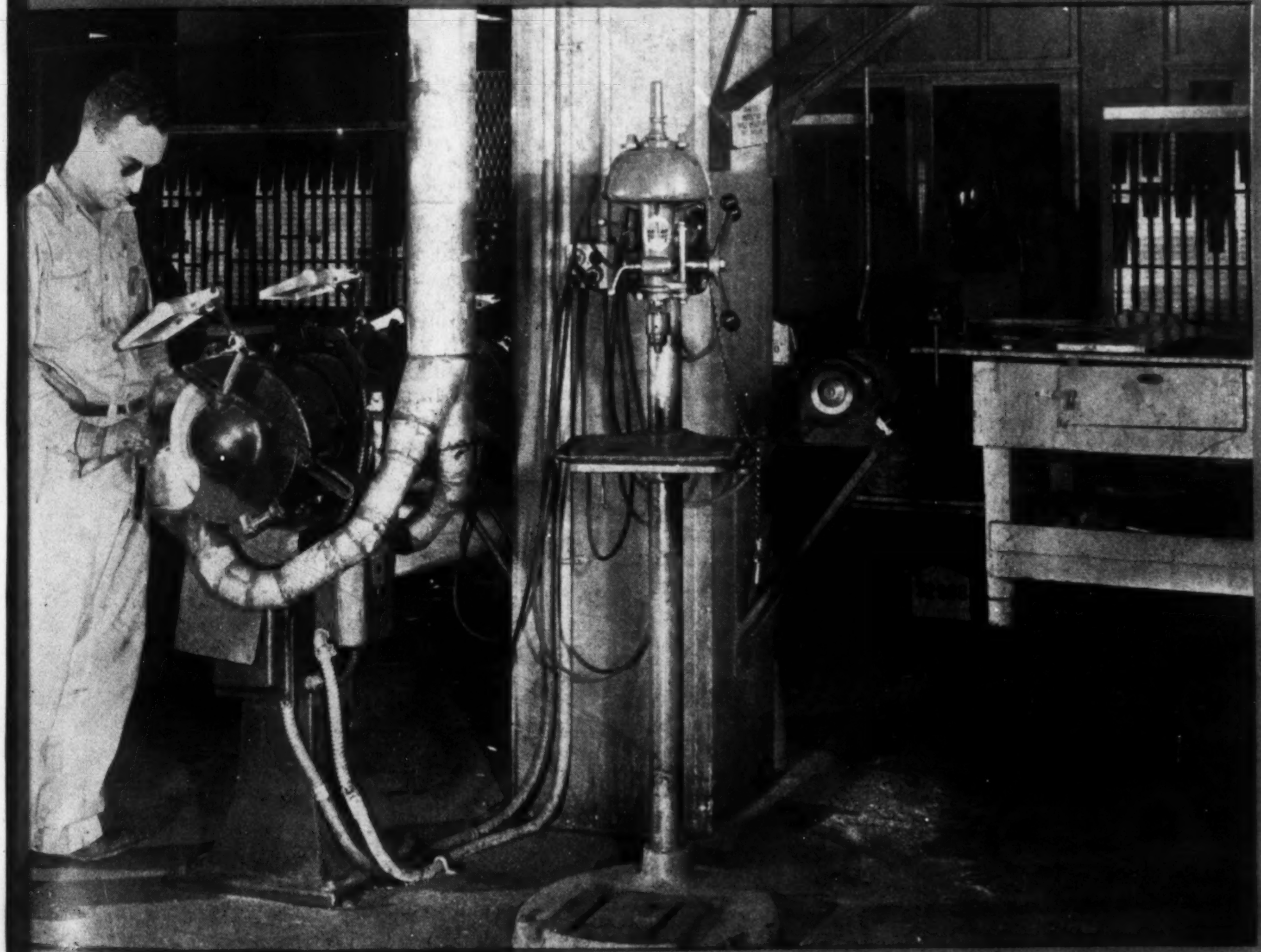
e 111 — *Journal Section of the American Society of Heating and Ventilating Engineers*



Should air be recirculated from industrial exhaust systems? — that's the question asked (and answered) in Allen D. Brandt's article this month

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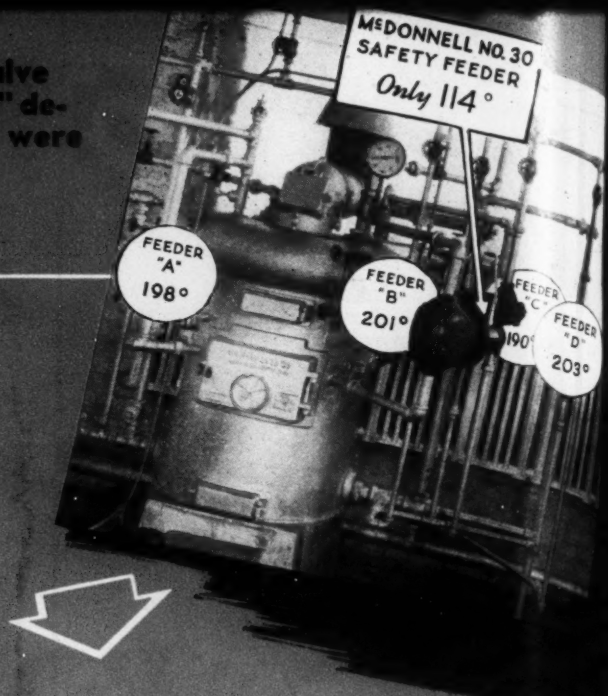
A test that made feeder history—feed-valve temperature of McDonnell "cool-feed-valve" design was only 114° F. Other temperatures were above 190° F.



The No. 47-2 is today's exponent of the cool feed-valve feeder cut-off combination for boilers below 5000 sq. ft. capacity; maximum steam pressure, 25 lbs. It is also made without low water cut-off switch for hand-fired boilers.

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We called this design the "Cool Feed-Valve" (U. S. Pat. No. 1,934,486). The photo reproduced above shows the test we made in June 1929 in comparison with other makes of boiler feeders. Note that the feed-valve temperatures of other feeders was in excess of 190° F., while the McDonnell feed-valve showed only 114° F. At 114 degrees scale usually does not form; at 190° or more it is certain to form.

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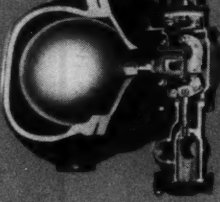

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Published monthly by the Keeney Publishing Co., 6 North Michigan Avenue, Chicago 2, Illinois. Telephone: State 6916. Subscriptions: U.S. and possessions, Canada, Mexico, Central America, South America, $3.00 per year; other, $6.00. Current copies, U.S. and possessions, 35c each, back copies, 60c each. January 1947 issue, $1.00 per copy. Member Audit Bureau of Circulations and Associated Business Papers, Inc. Copyright 1947 by the Keeney Publishing Co.

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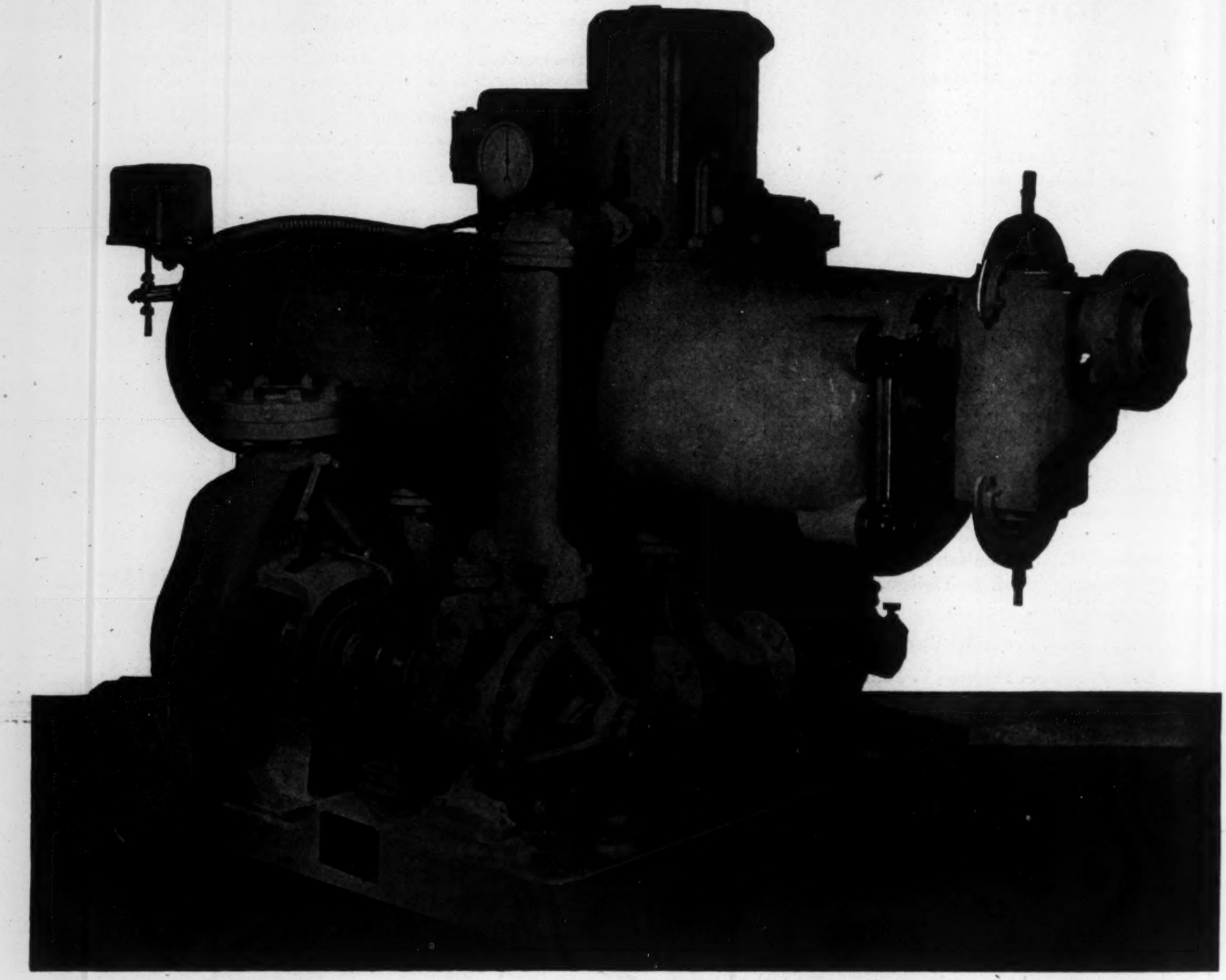
Where Heat Must Not Fail– Install this SAFE Heating Pump!



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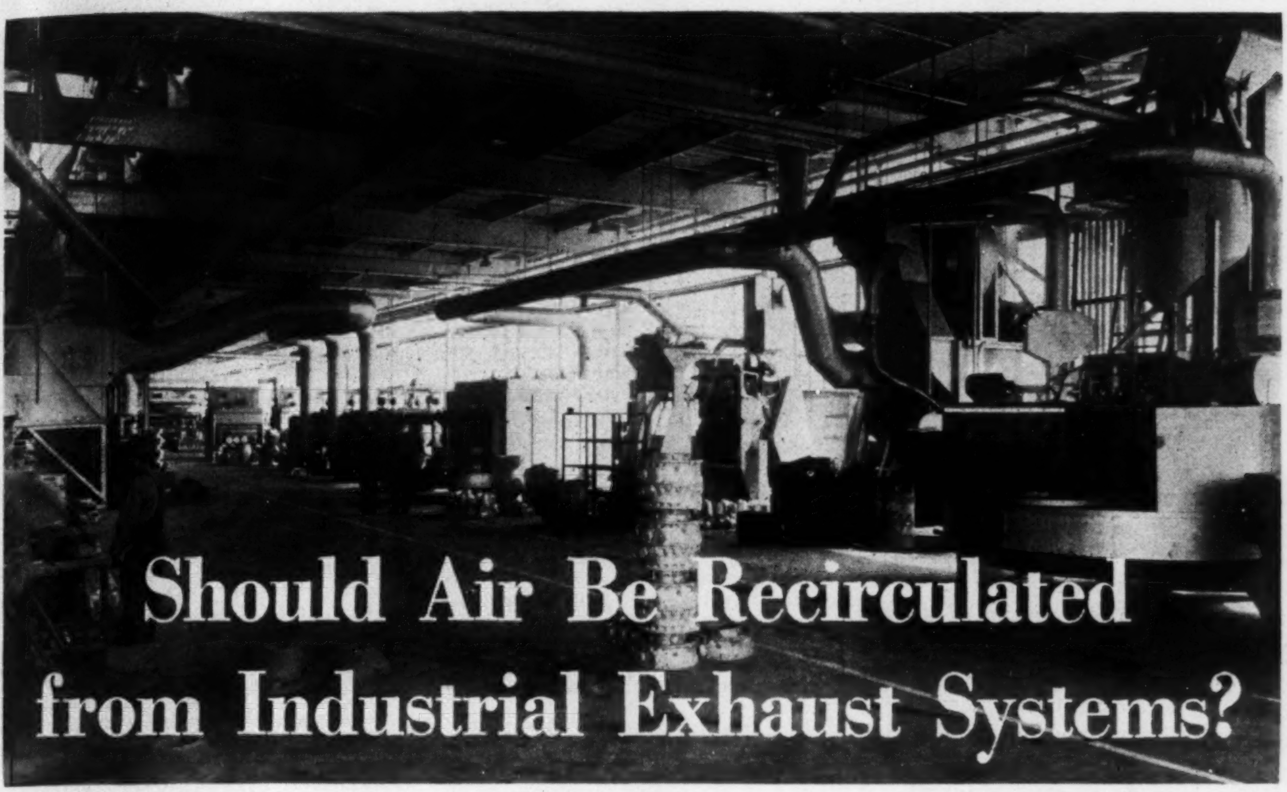


Should Air Be Recirculated from Industrial Exhaust Systems?

Allen D. Brandt, Industrial Hygiene Engineer, Bethlehem Steel Co., Tells What to Consider When the Problem of "To Recirculate or Not To Recirculate" Arises in Industrial Ventilation

FEW (IF ANY) problems in the field of industrial health engineering are as difficult of general or standardized solution as that of recirculating air from industrial local exhaust systems. This is due not so much to fundamental differences of opinion between industrial hygiene personnel as to differences in the conditions prevailing from one job to another, one industry to another, one substance to another, or even one collector to another.

Thus, if the primary reason for recirculating air is one of heating cost, the argument in its favor is much weaker in a southern industry than in a northern one; if the substance exhausted is of a nuisance character, there is less danger in recirculating than if the substance is toxic; if the collector is automatic and relatively foolproof, there is less danger in recirculating than if the collector must be regulated manually and goes out of kilter on the least provocation; and if the recirculation rate is small compared to the room content or the general ventilation rate, there is less danger than if the recirculation rate is high in relation to the room content or the general ventilation rate.

It is readily apparent, then, that the problem of recirculation can be decided best—and, probably, even satisfactorily—only if each proposed installation is given careful individual study. Generalizations must of necessity be either very unfair on the one hand or fraught with serious danger on the other. This poses a most difficult problem to governmental regulatory agencies such as state, city, and federal health and/or labor departments. Many occupational disease control or safety codes make no specific mention of this subject. Some few codes or proposed regulations permit recirculation provided that it does not create a health hazard—each such existing or planned installation to be considered individually on its own merits and to be approved or disapproved accordingly. Still others flatly forbid recirculation.

When Is Recirculation Warranted?

It is not the aim or intent of this paper to argue for or against recirculation, but rather to present some of the valid pros and cons so that those who are faced with a problem of this nature may be better equipped to make the proper decision. With the development status of dust control and collecting equipment as it exists today, there can be little just argument against the policy of discouraging recirculation. Recirculation must never be considered merely for the sake of recirculating. Only when a condition is encountered which is difficult of solution without recirculation is its consideration warranted. In such event, all factors must be assigned their due significance and an unbiased decision should then be arrived at.

In no case should the health of workers on the one hand be bartered against pure monetary gain on the other. Safe and healthful working conditions are a "must," and the decision for or against recirculation must be made on the basis of the other relevant factors. Obviously, however, reason must not be thrown to the winds. A case must not be decided against recirculation just because it can be shown that the possibility of atmospheric contamination is more remote without recirculation than with it, any more than a 50 ton crane would be selected for a 10 ton job merely because the possibility of an accident is less. A fair and adequate factor of safety must be integrated into the considerations and beyond that the decision should be influenced only by the other pertinent factors.

What, then, are some of the more important advantages and disadvantages of recirculating air from industrial local exhaust systems? Let us examine the latter first, but before doing so, a word on what is meant by recirculation appears to be in order. As used in this paper, it will refer to the return of any portion, or all, of the air exhausted by ventilating systems which are primarily local exhaust systems to an occupied workroom or building.

Disadvantages of Recirculation

Returns Contaminated Air to the Workroom

Even though two other disadvantages follow, they are actually only other phases of this first disadvantage.

It cannot be denied that it is better to replace all exhausted air by clean air than to replace any part of it by contaminated air. This is not a discussion, however, of what is best but rather one of what is good enough. How important returning contaminated air to the workroom may be depends upon a few very influential circumstances. These are the toxicity of the contaminant, the absolute amount of the contaminant returned, and the general ventilation rate in the room. If these separate circumstances are permitted to combine into one which will cause the general workroom air or that breathed by the workers to become unhealthful, recirculation becomes dangerous. If, on the other hand, the conditions are such that it is highly improbable that the foregoing circumstances can combine to create a health hazard, recirculation may be considered with safety.

Danger of Collector Failure

Dust collectors or separators and other filtering devices are not 100 per cent effective, they are not infallible, nor are they foolproof. Consequently, some of the exhausted contaminant is being returned at all times if air is recirculated, and in the event of collector failure the amount returned is usually sufficient to create a serious health hazard. While the deficiency in perfect contaminant removal can be compensated for in the design calculations, such compensation is seldom possible for filter failure. This, then, is probably the most serious drawback to air recirculation from industrial exhaust systems.

EIGHT POINTS TO CONSIDER

PROBABLY THE MOST significant conclusion that can be drawn from Dr. Brandt's discussion (or from any study of the problem of recirculation) is that each decision on whether to recirculate or not must be made on the merits of the particular case in question. There are so many factors involved—most of which are variables—that it is impossible at this time to set up standards as to where to recirculate and where not to recirculate.

Some of the governing factors which enter into any sound decision are:

1) Do not recirculate or even give consideration to the possibility of recirculating solely for the purpose of recirculating. In other words, don't give any thought to recirculating air from local exhaust systems unless there is a sound reason for doing so, and unless it is highly impracticable or definitely impossible to do otherwise.

2) Recirculation must be discouraged. With the development of air filtration equipment as it stands today, it is not good sense to recirculate unless there is no other practical way out.

3) Do not recirculate air from local exhaust systems handling highly toxic materials unless (a) it can be shown that even with collector failure no serious health hazard will be created, (b) the collector is equipped with a reliable device which warns of failure, or (c) the system contains separate collectors in series.

4) Do not recirculate merely to reduce heating costs if by so doing an important potential health hazard is created. There are many places where air can be cleaned and recirculated with complete safety and in such cases the reduction or savings in heating costs is a valid consideration.

5) The capacity of the heating plant and distributing system are usually more compelling arguments for recirculation than the monetary savings resulting from reduced heating costs.

6) The total amount of contaminant returned in the air recirculated to an occupied building is more important, as a rule, than the concentration of the contaminant in the recirculated air.

7) Packaged or self-contained units provide greater flexibility of operations than fixed or central systems, a very important factor in most industries.

8) Recirculation is sometimes necessitated by the difficulty of running discharge stacks to a suitable point on the outside.

Some of the common causes of collector failure are: failure to turn on the water at wet collectors; failure to clean dust from fabric filters and from cyclones; tears in filter fabrics; failure to accomplish a dust seal when renewing filter fabrics or when replacing them; and failure to maintain proper rate of air flow through the collector (the filtering efficiency of some collectors drops as the rate of air flow through them increases, and of some as it decreases, substantially from the recommended value). It is apparent that most of the failures are chargeable to poor maintenance, a subject which is covered in the next paragraph.

Inadequate Maintenance of Ventilating Equipment

Too frequently, industrial exhaust ventilating equipment is not given the inspection, care, and maintenance it deserves. As a result, the systems are not doing the job they were designed to do and perfectly capable of doing if properly maintained. The calculations on which the recirculation rate is based are then knocked into a cocked hat and the degree of atmospheric contamination in the workroom increases to an unhealthful level.

Evaluating a Proposed Recirculating System

Before proceeding to a discussion of the arguments in favor of recirculation, let us examine the foregoing disadvantages from an impartial and factual viewpoint to derive a sound appraisal of the significance of the circumstances involved for use in an accurate evaluation of any proposed recirculating system.

As stated previously, it is better

not to recirculate any air from an industrial exhaust system unless there are compelling reasons for doing so. Consequently, if recirculation is being considered, it is assumed that there is just reason for it. The important factor in connection with the air returned to the workroom is not so much the concentration of the contaminant in the air as the total amount of contaminant returned. In other words, the net degree of atmospheric contamination will usually be lower if, for example, 1000 cfm of air containing 400 parts per million of contaminant are returned to the atmosphere than if 5000 cfm of air containing 200 ppm of contaminant are returned even though 200 ppm may be the same as the maximum allowable concentration. There are exceptions, of course, such as when the excessively contaminated returned air is blown directly into the breathing zone of workers, thereby preventing adequate dilution with room air, or when the rate of recirculation is a too large percentage of the total ventilation rate. These conditions occur, however, only if the design is faulty and can be prevented if thought is given to them in the design calculations.

Air from local exhaust systems handling highly toxic materials such as lead and quartz should not be recirculated at present. If and when collector efficiency is improved and collectors become more nearly infallible and foolproof, this rule may be changed, but with conditions as they exist today it is decidedly unwise to recirculate such air.

There appears to be one type of exception to this rule, but it is not really an exception if we adhere strictly to the definition of a local exhaust system. This apparent exception can best be illustrated by an example that the author experienced several years ago—cleaning large, dissimilar steel castings by pneumatic chipping. Since the workers' noses were close to the chipping tools, their dust exposure was very high, but the general atmospheric dust concentration in the chipping area was only in the order of 20 million parts per cubic foot and less, most of the contaminant being metallic dust. The work was done in a large building; let us assume that the general ventilation rate through the chipping area was 30,000 cfm (a rough approximation actually indicated it to be less). The only practical way to reduce the workers' exposure to a safe level, let us say 5 mppcf for this illustration, would be to provide downdraft ventilation through floor grids which underlie the entire chipping area—about 15 ft x 40 ft in dimensions. Since some of the chipping was done at a distance of 3 or even 4 ft from the floor, it is believed that the design velocity would need to be about 400 fpm. The total required exhaust rate therefore would be 400 × 15 × 40 = 240,000 cfm. This is eight times the existing ventilation rate and the dust concentration in the exhaust air would therefore be about 2.5 mppcf.

Obviously this air has a very low dust loading and some of it could be returned to the room even without a collector in the system. A simple calculation will show that if half, or 120,000 cfm, were discharged to the outside and the remainder recirculated, the general room concentration would be only about 5 mppcf, which is a safe value. A collector would be needed at least in the discharge stack to reduce the amount of dust thrown outside. If all of the exhausted air were passed through the collector the room concentration would be reduced a great deal and even in the event of collector failure the conditions would still be safe. Here, then, is an example where recirculation may be used safely with a system handling a toxic material. As indicated previously, the exhaust system in this illustration is by definition a general ventilating system, not local exhaust. The general rule that air from *local exhaust systems* handling highly toxic contaminants should not be recirculated is still valid.

Another important factor in deciding whether it is safe to recirculate air or not is the ratio of the recirculation rate to the general ventilation rate of the room or occupied space to which the air is to be returned. Obviously, if the local exhaust system in question provides the only positive general ventilation existing in the room, very little if any of the air can be recirculated safely. If, on the other hand, the local exhaust rate is only a small fraction of the total ventilation rate, it may be possible to recirculate as much as 100 per cent of the air from the local exhaust system. Examples of such practice are unit dust collectors at grinding wheels.

Danger of Collector Failure

So much for the first disadvantage. We come now to the second—the danger of collector failure. This—in the author's opinion—is the crux of the problem. If collectors were essentially foolproof or

This is a typical buffing department where various metallic objects are polished or buffed. Dust collector located in the background is frequently arranged for either discharge to the atmosphere or recirculation of the clean air, dependent upon plant conditions.

if there were some mechanism which warned of a failure, the practice of recirculation would have little inherent danger. Since such is not the case at present, the danger associated with recirculation becomes a function of several factors—such as ratio of recirculated air to general ventilation rate, toxicity of the contaminant, and the absolute amount of contaminant in the recirculated air.

The importance of maintenance as it affects the danger associated with recirculation is probably overrated. This does not mean that the danger is less than indicated, but rather that in general the danger exists whether some air is being recirculated or not. In other words, if a local exhaust system operates unsatisfactorily because of poor maintenance, the chances are good that the net result will be an increase in the contamination of the room air irrespective of whether air is recirculated or not. This is not always true, but it is unfair to point a finger specifically at recirculation in this connection when the same circumstances usually prevail even if none of the exhausted air is being recirculated.

Reasons for Recirculating

Let us now examine—on the same matter-of-fact basis—some of the arguments in favor of recirculation.

Heat Loss

Even though heat loss is usually the first item that comes to mind when considering recirculation of exhausted air, the increased heating cost *per se* is seldom the most important factor that enters the considerations. The heating cost in northern climates is not small, to be sure—about $25 per 1000 cfm per 8 hr day per season—but more compelling by far in most existing buildings and industries is the lack of heating plant and distribution system capacity. To permit wasting all the air from the ever increasing use of local exhaust systems would frequently require the construction of a larger heating plant and a complete revamping of the distribution system.

The implications are obvious, and the decision is therefore frequently a very simple one: either some of the exhausted air must be recirculated or the local exhaust system cannot be installed; or, if installed, the affected workers must work in cold rooms in winter. Needless to say, this reason for recirculating is much stronger in northern areas than in the south.

Flexibility of Installation

Production methods in any industry are forever changing. In the automotive industry, for example, there is a substantial change in operational methods and in locations of specific operations annually. Consequently, it is desirable wherever practicable to have all equipment made up of self-contained units which can be relocated without a major construction undertaking.

This requirement applies not only to ventilating equipment but to all machinery; witness the replacement of long drive-shafts by individual motors at most machines in industry during recent years. It is apparent, therefore, that the problem of industrial changeover is much greater if fixed and complicated installations must be used than if "packaged" or self contained installations can be employed.

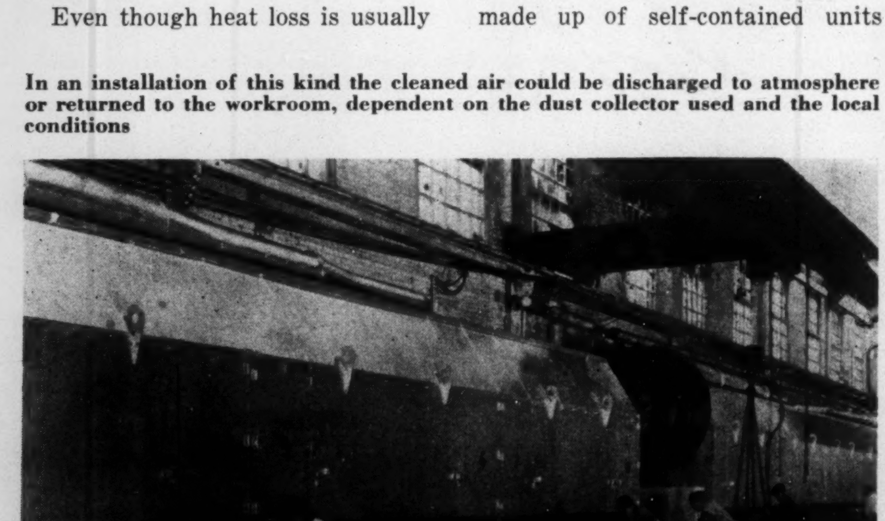
Difficulty of Discharging Air to the Outside

Not infrequently, it is impractical or very difficult to discharge the air to the outside. High buildings or cranes necessitate very expensive and (from an engineering or architectural viewpoint) unsatisfactory installations. If the discharge stack from a system on the first floor of a high building cannot be run essentially vertically to the roof, it may need to be run a considerable distance horizontally to an outside wall and then vertically on the outside to a suitable point above the roof. In modern and other buildings that were planned with the aesthetic appeal in mind, such procedure creates a decided eyesore which is most undesirable.

The alternative, if recirculation is barred, is to construct common discharge stacks at several locations around the building and to run all fan discharges horizontally for considerable distances to these stacks. This (from an engineering, maintenance, and operational viewpoint) is also to be avoided if possible. Similarly, underground or beneath-the-floor tunnels require a major structural change in most buildings which in addition to being very costly have the same objections given for long horizontal duct runs.

Anyone who has had experience in work of this nature can think of other pros and cons on this subject. Since this is not a debate, no attempt will be made to cover the subject completely. Suffice it therefore in this paper to have discussed some of the more important factors.

In an installation of this kind the cleaned air could be discharged to atmosphere or returned to the workroom, dependent on the dust collector used and the local conditions



[The courtesy of the American Air Filter Co. in furnishing the accompanying illustrations is gratefully acknowledged.]

Methods of Making PIPING FLEXIBILITY *Analyses*

THE MODEL TEST METHOD

By Lale C. Andrews

Mechanical Engineer, The M. W. Kellogg Co.

YEARS BEFORE THE formal adoption of the scale model as an engineering tool in the design of piping systems, draftsmen were sitting at their boards bending bits of wire into tangible miniatures of their layouts. By springing these tiny models—improvised from pipe cleaners and paper clips—they attempted to preview, in reduced facsimile, the flexural characteristics of their designs.

The value of the small scale prototype as an aid to visualization was apparent. Hence, it was a natural step to invoke the laws of similitude to fashion this rudimentary device into a technically useful instrument of design.

The model test method of pipe stress analysis has not been developed as a competitor of mathematical procedures. Its general purpose has been to offer a solution by experiment of those layouts too intricate for convenient calculation. With greater refinement than its elementary progenitor, the model also still furnishes visual and measurable evidence of the interaction of members that may not always be clear from inspection of a drawing or from calculated results. It also provides an inexpensive medium for experimentation, both in design and in the investigation of fundamentals.

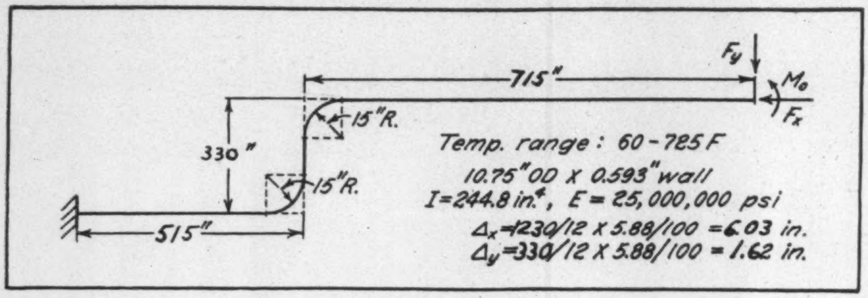
As a demonstration of the detailed procedure involved in this type of analysis, the solution of the single plane bend shown in Fig. 1 is presented in its entirety. To avoid repetition, only the salient facts and the test results are given for the Hovgaard bend shown in Fig. 2. However, the simple general formulas for determining end reactions are shown, so that the additional readings and computations involved in a multiplane bend are self-evident.

Following these two examples, the results of some additional tests on the Z-bend are given, using models of different characteristics. These tests indicate the effects of the Karman flexibility factor.

Test Procedure and Apparatus

The apparatus used in the following tests was described in the August 1945 issue of Heating, Piping & Air Conditioning. However, to facilitate an understanding of the results, a brief explanation of the test procedure and descrip-

THERE ARE numerous methods of analyzing the flexibility of piping systems and a great amount of material on this important subject has been published. In the June 1946 HPAC, Sabin Crocker and Arthur McCutchan reviewed the various methods, and suggested that the advocates of the different schemes each briefly outline the merits of his method and show the solution of two problems; in this way, the reader can judge for himself the suitability of the different calculation procedures in his own piping work. . . . S. W. Spielvogel followed this suggestion in the July issue, explaining the essentials of the elastic center method, and in September M. J. Fish discussed the graphical method. In November, W. G. Hooper covered the tabular integration method and solved the two problems given by Messrs. Crocker and McCutchan by that means. In the January 1947 number, R. C. DeHart explained the moment distribution method and in May 1947, H. V. Wallstrom reviewed the general analytical method. This month, the model test method is discussed



F_y
715"
M_o
F_x
15"R.
330"
15"R.
515"
Temp. range: 60-725 F
10.75" OD x 0.593" wall
I=244.8 in.⁴, E=25,000,000 psi
Δx=1230/12 x 5.88/100 = 6.03 in.
Δy=330/12 x 5.88/100 = 1.62 in.

Fig. 1—Z bend with welding elbows

tion of the apparatus will be repeated.

The tests are made upon scale models of the pipe lines. The magnitude and direction of the free thermal expansion of the line is calculated from an assumed fixed point which is usually one end of the line. Holding both ends fixed against rotation, the assumed free end of the model is displaced in the calculated direction some convenient fraction of the actual expansion.

This springing of the model creates a moment and a force at each end in known proportion to those which would be produced at the ends of the pipe line under thermal expansion. The moments and forces are each resolved with respect to the coordinate axes and their components measured. The combined operations are performed by the instruments shown in the photographs of the models under test, and indicated diagrammatically in Fig. 3.

The measuring heads, as they are called, support the model. One is firmly fixed to each end and consists essentially of a six-arm cross aligned with the three coordinate axes. An electrical strain gage is suitably mounted on a deflecting support near the end of each arm. The gages are indicated in Fig. 3 by arrows marked with letters and subscripts.

Readings are taken on a control panel to which the heads are wired, and indicate the magnitude and direction of the force acting at the point of measurement of each arm. These points are all 2.500 in. from the center of the cross. Hence, when a force and a moment are applied by the model at its point of fixation to the cross, their corresponding components at the center of the cross, when it is in the position shown, are given by the following formulas:

$$F_x = x_3 + x_4 \quad \text{.............}[1]$$
$$F_y = y_5 + y_6 \quad \text{.............}[2]$$
$$F_z = z_1 + z_2 \quad \text{.............}[3]$$
$$M_x = 2.5\ (z_2 - z_1) \quad \text{.........}[4]$$
$$M_y = 2.5\ (x_4 - x_3) \quad \text{.........}[5]$$
$$M_z = 2.5\ (y_6 - y_5) \quad \text{.........}[6]$$

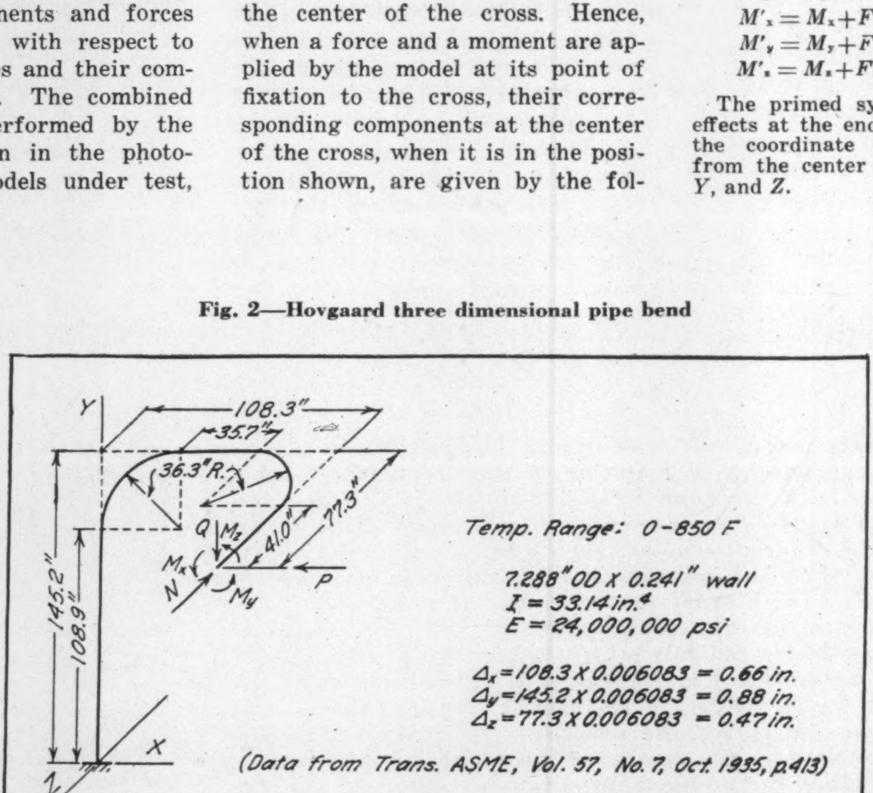
The subscripts are permanent reference numbers for identifying the points of measurement, regardless of the position of the head with reference to the coordinate axes.

The effects of the component forces and moments thus obtained may be transferred back to the end points of the model by means of the customary formulas.

$$F'_x = F_x \quad \text{..................}[7]$$
$$F'_y = F_y \quad \text{..................}[8]$$
$$F'_z = F_z \quad \text{..................}[9]$$
$$M'_x = M_x + F_y \times Z - F_z \times Y \quad .[10]$$
$$M'_y = M_y + F_z \times X - F_x \times Z \quad .[11]$$
$$M'_z = M_z + F_x \times Y - F_y \times X \quad .[12]$$

The primed symbols represent the effects at the end point of the model, the coordinate distances of which from the center of the cross are X, Y, and Z.

Fig. 2—Hovgaard three dimensional pipe bend



Y
108.3"
35.7"
36.3"R.
77.3"
41.0"
Q
M_z
M_x
N
M_y
P
145.2"
108.9"
X
Z
Temp. Range: 0-850 F
7.288" OD x 0.241" wall
I = 33.14 in.⁴
E = 24,000,000 psi
Δx=108.3 x 0.006083 = 0.66 in.
Δy=145.2 x 0.006083 = 0.88 in.
Δz=77.3 x 0.006083 = 0.47 in.

(Data from Trans. ASME, Vol. 57, No. 7, Oct. 1935, p.413)

The values may then be converted to the scale of the pipe line by means of the following relationships:

$$\frac{F_p}{F_m} = \frac{E_pI_p}{E_mI_m} \times \frac{\Delta_p}{\Delta_m} \times \frac{L^3{}_m}{L^3{}_p} \quad \ldots [13]$$

$$\frac{M_p}{M_m} = \frac{E_pI_p}{E_mI_m} \times \frac{\Delta_p}{\Delta_m} \times \frac{L^2{}_m}{L^2{}_p} \quad \ldots [14]$$

in which F = force; M = moment; E = modulus of elasticity; I = moment of inertia; Δ = amount of expansion (or displacement) of the "free" end with reference to the fixed end; and L = length. The subscripts m and p refer to the model and the pipe, respectively.

The determination of these end effects constitutes the solution of the problem as defined in the opening article of this series.

Models of Bends Built

For Test No. 1, a model of the single plane bend was built of steel tubing having nominal dimensions of 0.500 in. OD × 0.028 in. wall thickness. The curved portions were bent to a centerline radius of 0.75 in., giving them a theoretical flexibility factor of 4.33 compared to that of the actual pipe of 4.71. These figures are obtained from the Karman formula:

$$k = \frac{12\,h^2 + 10}{12\,h^2 + 1} \quad \ldots\ldots\ldots\ldots [15]$$

in which $h = tR/r^2$ and t, r, and R are the pipe wall thickness, the mean pipe wall radius, and the centerline radius of the bend, respectively.

The length scale was 0.0457 in. = 1 in., based on a calculated bend radius of 0.686 in., which would have given a k of 4.71. Flattening of the bent portion during bending was held to a minimum by the use of an internal mandrel and an external die. The product of the modulus of elasticity and moment of inertia was found by test to be 37,180.

The model was set up as shown at "A" in Fig. 4 and as indicated diagrammatically in Fig. 3. An initial or zero reading was taken on each point of measurement. The displacements were then applied and a stressed reading taken. The differences between the two sets of readings represent the forces in pounds applied at the six points of each head. All displacements and readings were repeated for verification.

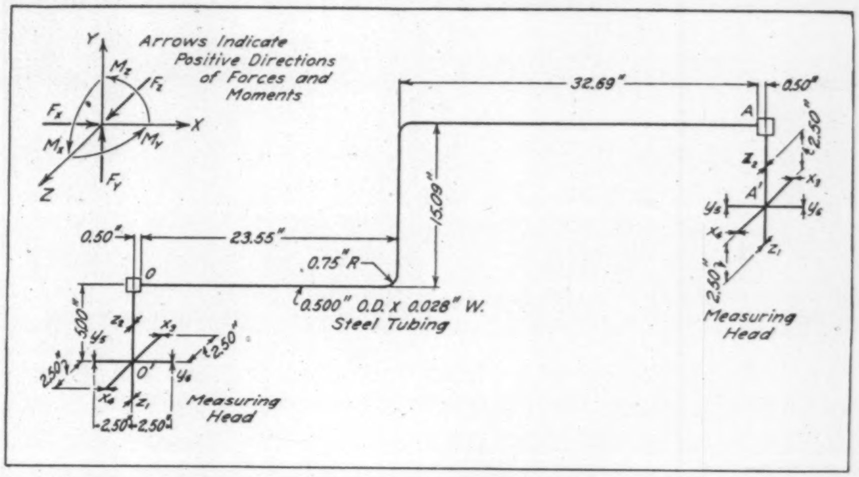


Fig. 3—Diagrammatic illustration of tubing model of Z bend connected to measuring heads

HEAD O'

	x_3	x_4	y_5	y_6	z_1	z_2
Initial (Zero) Reading	+ 0.45	— 1.50	— 0.17	— 0.35	....	....
Stressed Reading	— 3.65	— 5.57	— 5.34	+ 1.47	....	....
Difference	— 4.10	— 4.07	— 5.17	+ 1.82	....	....

HEAD A'

	x_3	x_4	y_5	y_6	z_1	z_2
Initial (Zero) Reading	— 3.91	+ 0.05	— 1.92	+ 11.77	....	....
Stressed Reading	+ 0.18	+ 4.13	+ 16.86	— 3.66	....	....
Difference	+ 4.09	+ 4.08	+ 18.78	— 15.43	....	....

As the displacements applied in this case were one-twentieth of the magnitudes of the actual expansions,

$$\Delta_x = 0.05 \times 6.03 = 0.3015 \text{ in.}$$
$$\Delta_y = 0.05 \times 1.62 = 0.081 \text{ in.}$$

For convenience, the forces and moments were converted to full scale at the centers of the heads and then transferred to the ends of the line.

The conversion ratios, from equations [13] and [14], were as follows:

$$\frac{F_p}{F_m} = \frac{25{,}000{,}000 \times 244.8}{37{,}180} \times \frac{1}{0.05} \times \left(\frac{0.0457}{1}\right)^3 = 314.72 \quad \ldots\ldots\ldots\ldots [16]$$

$$\frac{M_p}{M_m} = \frac{25{,}000{,}000 \times 244.8}{37{,}180} \times \frac{1}{0.05} \times \left(\frac{0.0457}{1}\right)^2 = 6882.9 \quad \ldots\ldots\ldots\ldots [17]$$

The forces and moments at the centers, O' and A', of the measuring heads were calculated from equations [1], [2], and [6], and converted to the scale of the pipe.

HEAD O'

$$F_{x_{O'}} = (-\ 4.10 -\ 4.07) \times 314.72 = -\,2{,}571 \text{ lb} \ldots\ldots\ldots\ldots [18]$$

$$F_{y_{O'}} = (-\ 5.17 +\ 1.82) \times 314.72 = -\,1{,}054 \text{ lb} \ldots\ldots\ldots\ldots [19]$$

$$M_{z_{O'}} = (+\ 1.82 +\ 5.17) \times 2.5 \times 6882.9 = +\,120{,}279 \text{ in.-lb} \ldots\ldots\ldots\ldots [20]$$

HEAD A'

$$F_{x_{A'}} = (+\ 4.09 +\ 4.08) \times 314.72 = +\,2{,}571 \text{ lb} \ldots\ldots\ldots\ldots [21]$$

$$F_{y_{A'}} = (+\,18.78 - 15.43) \times 314.72 = +\,1{,}054 \text{ lb} \ldots\ldots\ldots\ldots [22]$$

$$M_{z_{A'}} = (-\,15.43 - 18.78) \times 2.5 \times 6882.9 = -\,588{,}660 \text{ in.-lb} \ldots\ldots\ldots\ldots [23]$$

These effects were transferred to the ends of the line by equations [7], [8], and [12]. Since the values had already been converted, the dimensions of the measuring head had also to be converted to the scale of the actual pipe.

$$M_{z_O} = +\,120{,}279 + (-\,2{,}571) \times 5 \times 21.87 - (-\,1{,}054) \times 0.5 \times 21.87$$
$$= -\,149{,}329 \text{ in.-lb} \ldots\ldots\ldots\ldots [24]$$

$$M_{z_A} = -\,588{,}660 + (+\,2{,}571) \times 5 \times 21.87 + (+\,1{,}054) \times 0.5 \times 21.87$$
$$= -\,295{,}996 \text{ in.-lb} \ldots\ldots\ldots\ldots [25]$$

The values thus found are tabulated below for convenience in comparing them with those from the tests that follow. The signs are consistent with the coordinate diagram in Fig. 3 and represent the moments and forces acting upon the restraints. The moments are expressed in foot-pounds and the forces in pounds.

TEST NO. 1—SINGLE PLANE BEND OF TUBING

End	M_z	F_x	F_y
O	—12,444	—2,571	—1,054
A	—24,666	+ 2,571	+ 1,054

Test No. 2 was performed upon a model of the Hovgaard bend shown in Fig. 2, and built of steel tubing with nominal dimensions of 0.750 in. OD × 0.025 in. wall thickness. The length scale was 0.104 in. = 1 in. The flexibility factor of the curved members was 2.27, comparing closely with the calculated factor of 2.29. The model is shown set up in the machine in Fig. 5, and the end effects are tabulated as follows:

TEST NO. 2—HOVGAARD BEND OF TUBING

End	M_x	M_y	M_z	F_x	F_y	F_z
O	—5,735	+ 1,524	+ 10,479	—1,752	—1,709	—643
A	+ 8,953	—6,932	— 4,720	+ 1,752	+ 1,713	+ 642

Where the flexibility factors in a layout are of serious importance, tubing models are used as in the foregoing tests. Experience with a large number of complex models, however, has taught the practical value of employing solid rods in their construction wherever feasible. Where small flexibility factors are encountered and where the curved members are a small part of the overall length of pipe, little—if any—superfluous flexibility results from this practice. Any error that may arise is on the side of safety.

Flexibility Due to Curved Members

As the examples considered both show a substantial additional flexibility due to the curved members, the reader may be interested in observing its effects. The single plane layout offers an opportunity to observe both the effects of the Karman flexibility factor and evidence regarding its quantitative accuracy. For these observations, the results of two additional tests are given.

The first was made on a model of solid rod of a single diameter. If the curved members of the tubing model were appreciably more flexible than equal lengths of their straight tangents, the end effects for this model should be generally lower than those for the solid model, when both are converted to the scale of the actual pipe. Further, if the Karman factor is quantitatively accurate, it should be possible to duplicate it in a solid model of a single plane bend. To do so the curved members need only be made proportionately more flexible than the straight members by using rods of a proportionately smaller moment of inertia. The converted end effects should be reasonably comparable to those of the tubing model. The conditions outlined are satisfied in Tests No. 3 and 4.

For Test No. 3, the model, shown at "B" in Fig. 4, was built of 5/16 in. diameter solid steel rod to a length scale of 0.04 in. = 1 in. The end effects determined from this test were as follows:

TEST NO. 3—SINGLE PLANE BEND OF 5/16 IN. DIAMETER SOLID ROD

End	M_z	F_x	F_y
O	—14,123	—3,260	—1,327
A	—31,914	+ 3,248	+ 1,327

In Test No. 4, the straight members of the model, shown at "C" in Fig. 4, were of 11/32 in. diameter rod and the curved members of 15/64 in. diameter rod. The moment of inertia of the larger rod is 685.39×10^{-6} and that of the smaller 148.17×10^{-6}. This is equivalent to a flexibility factor for the curved members of 4.63.

The results of this test are as follows. A comparison with the results of single plane tests above shows them to be much closer to those of Test No. 1 than to those of Test No. 3. The comparative results lend support to the Karman theory.

TEST NO. 4—SINGLE PLANE BEND OF 11/32 IN. AND 15/64 IN. DIAMETER SOLID ROD

End	M_z	F_x	F_y
O	—12,969	—2,538	—1,044
A	—25,203	+ 2,538	+ 1,044

Why Model Test Is Used

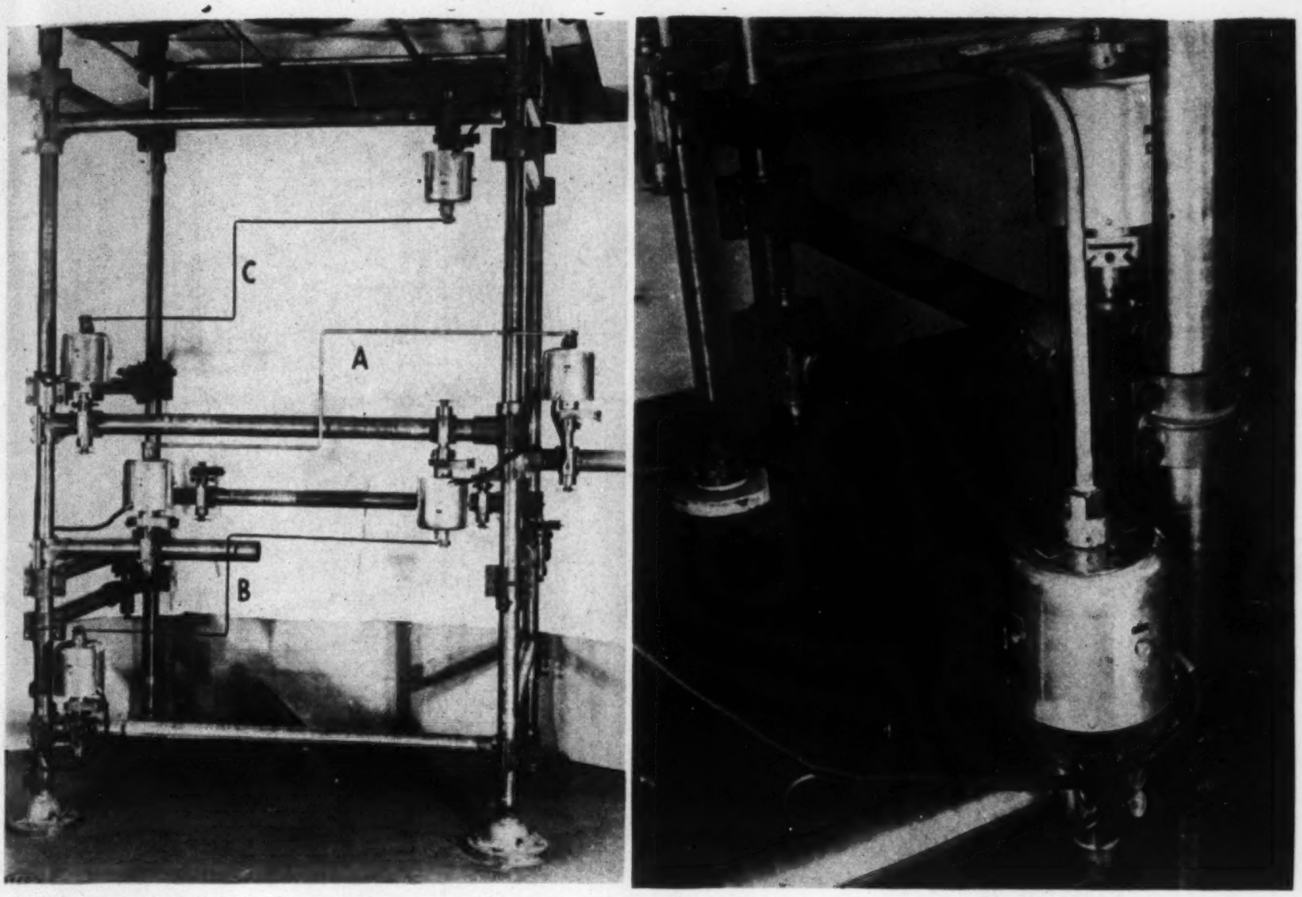
Though the model test has been used in many investigations of the type described, its development grew out of the necessity for some means of solving the more intricate piping layouts quickly and accurately. The usual approximate mathematical method of breaking up the complicated systems into simpler ones that can be solved conveniently has been shown to be subject to large errors. In some cases, such approximate solutions may result in expensive over-design. In others, the effect of a large pipe in one part of the system on a small connection in another part may be ignored with possibly disastrous results.

The model test is also useful in the solution of problems, even of simple layouts, in which a number of partial restraints are involved. It is particularly convenient where it is desired to achieve a specific effect with a restraint. The stop or guide can be moved about until its possibilities are exhausted, while only those readings need be taken that are of interest.

Such a case recently arose in the design of the main steam line of a midwestern power plant. The line had been designed with a stop near the superheater outlet for the purpose of relieving the thrust on the outlet header. A model test showed that, in all possible positions, the restraint actually increased the moment in the outlet connection to the point of overstress. The stop was removed and the line and header were found to be satisfactory without it.

Loops and other experimental sections of pipe can also be added and replaced in many instances without removing the model from the machine. Here again, only such readings need be taken as concern the designer.

In the design and placing of spring hangers, the visual inspection of the movement of the model, especially where bowing of long runs is a factor, is an important asset. Actual field measurements during thermal expansion have been found to corroborate the results of deflection model tests.



Left: Fig. 4—Tests on three models of the Z bend demonstrate the effect of the Karman flexibility factor. "A" shows tubing model; "B," model of solid rod, and "C," model of solid rod with curved members of reduced section. Right: Fig. 5—Tubing model of Hovgaard bend

Natural Gas Stored Underground in Steel Pipe

A PILOT INSTALLATION using pressure vessels fabricated from lengths of seamless steel pipe for storing 1,250,000 cu ft of natural gas at 2240 lb per sq in. has recently been placed in service by the Public Service Co. of Northern Illinois near Kankakee.

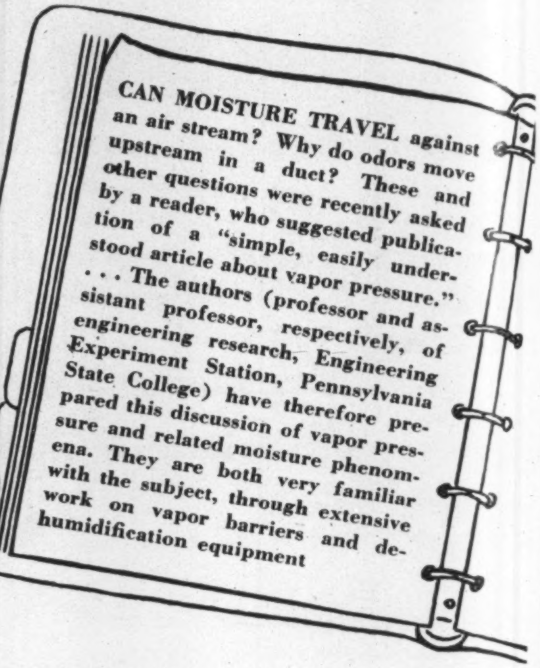
It is intended to supplement low pressure distribution in the Kankakee area and provide an emergency supply for high pressure customers in the area normally supplied from the high pressure distribution feeder main from Mattison, Ill. Another unit capable of storing 40,000,000 cu ft is now in process of construction near Mt. Prospect, Ill. The basic design was developed by the Public Service Co. of Northern Illinois, Stone and Webster Engineering Corp., and National Tube Co.

The seamless pipe, of alloy steel having a yield point in excess of 80,000 lb per sq in., is furnished by the mill in 40 ft lengths, 24 in. OD and 0.512 in. wall thickness. Each end is hot swedged to contour in five stages, using a 2000 lb steam hammer. One end is then cut to length and rough bored, after which the cylinder is normalized to produce the desired grain structure in the steel. Following this operation the cylinder is shot blasted and both necks finished to the required size in a special horizontal boring mill. The cylinders are then subjected to a 2800 lb per sq in. hydrostatic test in a water jacket to determine that the permanent set at this pressure does not exceed prescribed limitations, following which they are prepared to receive a mastic coating and the ends plugged for shipping.

Fifty lengths of pipe, fabricated into storage cylinders, arranged in five lines of eight units, four on each side of a manifold, were used at Kankakee. Each unit, on an average, has an internal volume of 109.66 cu ft and is capable of storing approximately 25,000 cu ft of natural gas. Of particular interest to companies using these storage units is the compressibility factor of natural gas, which shows maximum deviation from the laws of perfect gases near the pressure of 2240 lb per sq in. at which the gas is stored. Whereas approximately 160 cu ft of a perfect gas could be stored in 1 cu ft of space at 2240 lb per sq in. pressure and 40 F temperature, it is possible to store approximately 230 cu ft of natural gas under the same conditions. Forty lengths of pipe are considered sufficient for storing 1,000,000 cu ft of natural gas. Standard spacing for the tubular storage units is 8 ft end to end and 15 ft between center lines. All piping is coated and provided with cathodic protection.

Earth cover of 3 ft, 6 in. is sufficient to minimize seasonal temperature changes.

VAPOR PRESSURE
What It Is and Does



CAN MOISTURE TRAVEL against an air stream? Why do odors move upstream in a duct? These and other questions were recently asked by a reader, who suggested publication of a "simple, easily understood article about vapor pressure." . . . The authors (professor and assistant professor, respectively, of engineering research, Engineering Experiment Station, Pennsylvania State College) have therefore prepared this discussion of vapor pressure and related moisture phenomena. They are both very familiar with the subject, through extensive work on vapor barriers and dehumidification equipment

E. R. Queer and
E. R. McLaughlin
Explain
Moisture Phenomena

THE EFFECTS OF steam pressure in a locomotive are common knowledge—how it "chugs" out of the stack, roars out of the safety valve, and hisses around all the packing glands. The steam completely fills the boiler space and seeks to escape wherever it can. Since it exerts a force on the boiler walls, it has pressure.

Not so readily recognized are the physical properties of the same fluid at other conditions. Steam is the gaseous phase of water. When sufficient energy is given to a molecule in the liquid phase it will break away from the liquid and behave as a gas molecule. This exchange can occur at room temperatures as well as at the high temperatures in the locomotive. The phenomenon is called "evaporation" when it occurs at room temperature.

A gas molecule is free to travel in three dimensions—consequently, a gas completely fills the container which encloses it. The container may be compared to a room filled with bounding ping pong balls representing the molecules of the gas. As a flying ping pong ball strikes a wall and bounces back, it exerts a force on the wall during the brief period of contact. An extremely large number of balls continually bombarding a wall will exert considerable force. Likewise, a multitude of molecules striking the walls of the container exert a force which, when expressed as force per unit area, is called "pressure."

Saturation Pressure

If the container of water vapor is cooled, and meanwhile is decreased in size to maintain constant pressure, it will eventually reach a very important temperature. At this temperature the space in the container is saturated with as many water vapor molecules as it is possible for it to hold. Any further reduction in temperature will require a reduction in the number of gas molecules and condensation will appear. The space is saturated, and the pressure is the "saturation pressure" for the existing temperature. The temperature at which condensation is imminent is called the "dew point temperature."

For every temperature there is a definite and fixed saturation pressure. When the steam exists at a temperature above the saturation temperature for its pressure it is said to be superheated. Moisture at normal temperatures exists in the atmosphere as saturated and superheated steam. In the superheated condition, where the temperature is above the saturation temperature for the pressure, the ratio (expressed as a percentage) of existing pressure to the saturation pressure for the existing temperature is called "relative humidity." At saturation the relative humidity is 100 per cent. If the vapor pressure is maintained constant and the temperature is increased, the relative humidity will decrease—the ratio of pressures decreasing.

Dalton's Law

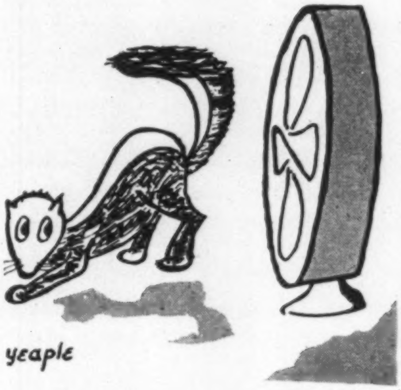
The earth's atmosphere is a mixture of gases, predominately nitrogen and oxygen with a small amount of water vapor and a trace of other gases. The art of air conditioning received a vital boost when a young physicist one day realized that in a mixture of inert gases, each gas behaved as if it occupied the space alone and was incognizant of the presence of any of the other gases. This scheme of nature has been formulated as Dalton's Law, which says (in effect) that the total pressure of a mixture of inert gases is equal to the sum of the pressures of the constituent gases. The total pressure of the atmosphere we know as barometric pressure. This total pressure is the sum of the pressures of the nitrogen, oxygen, water vapor, and other gases. It is frequently convenient, in analyzing an air conditioning problem, to ignore the other gases and consider only the pressure contributed by the water vapor.

Vapor Moves Against Air Pressure

Consider, therefore, some of the phenomena which are quite readily explained by vapor pressure. One of the most baffling is the movement of vapor against a slight positive air pressure. Vapor has been observed to travel from a humid room to a dry room in spite of the fact that the dryer room was under a slight positive pressure with respect to the humid room. Air will flow, of course, from the dry room to the humid room. At the same time the vapor pressure in the humid room is higher than the vapor pressure in the dry room, and since it is incognizant of the air, the vapor will tend to flow to the dry room. If the molecules travel upstream faster than they are carried downstream by the air movement, moisture vapor will travel from the humid room to the dry room.

The same reasoning applies to the problem of odors. The odors which are vapors will act in a like manner and the presence of the air or the water vapor will be only incidental. The odor, originating in its own pressure area, will travel upstream through a slight air movement, and the odor will be propagated through a duct against the air movement. (The presence or absence of humidity may make the olfactory nerves more responsive to odors, but that is quite apart from odor propagation.)

Development of a thunderhead over a rising column of air (Weather Bureau)



Pungent odors can travel against an air stream, due to vapor pressure

Dry Air Heavier Than Humid

When water vapor is added to air, some of the air must be displaced to maintain a constant total pressure. The vapor has a much lower density than the air which it has displaced. For this reason, dry air is heavier than humid air at the same temperature. This is contrary to the general impression that humid days are "heavy" days, and that dry days are "light" or much more comfortable.

The formation of beautiful cumulus clouds is natural evidence of the functioning of thermodynamics. On sunny days the ground surface is unevenly heated and definite convection currents are established. Over the warmer areas, the air is rising. As the column of air rises, the barometric pressure decreases at higher altitudes. The reduction in pressure allows the air to expand and in expanding it is cooled.

The column continues to rise until it reaches the "condensation level," where the temperature has been reduced to saturation temperature for the vapor pressure in the rising column. At the condensation level some of the vapor is condensed into very fine droplets which form the visible part of the cloud. The condensation releases the latent heat of condensation and still more energy is available for heating the column and making it rise. The system is self-propagating and will build up into the vertical formation known as a "thunderhead." If sufficient vapor and energy are present the process may continue until it is dissipated in a thunderstorm. The energy exchange is enormous and accounts for the severity as well as the short duration of storms of this type.

Artificial storms can be created if sufficient energy is strategically released. This has been demonstrated by dispersing large quantities of dry ice through air near the saturation temperature for the existing vapor pressure. The sublimation of the dry ice required energy at the expense of the air and the temperature was lowered until condensation occurred and dropped as precipitation.

Vapor Pressure in Buildings

Man has much more success at controlling moisture in buildings than he does at controlling the weather. Where it is desirable to maintain a vapor pressure differential, it is usually necessary to place a barrier in or on the walls. The exact location of the barrier depends upon the conditions maintained in the spaces on either side of the wall. To limit the latent heat load on an air conditioning system the barrier may be located in any convenient plane. There is very little temperature drop and the likelihood of condensation within the wall is remote. On the other hand, the winter heating season may impose severe conditions on a wall if the vapor barrier is not properly located.

A study of vapor pressures will indicate the proper location for the vapor barrier. The weather air is cold and consequently the vapor pressure is low. During the heating season the temperature inside the structure will be warm and quite frequently, due to respiration, cooking, laundry, or any process evolving moisture, the vapor pressure will be considerably above the weather vapor pressure.

Most building materials are rather permeable to moisture vapor and because of pressure difference vapor will be transmitted outward through the walls. When the weather is cold the materials near the outside of the wall will be cool. If the weather is cold enough to cool the materials below the saturation temperature for the vapor pressure existing in the wall space, condensation will occur within the structure. Moisture will continue to accumulate as long as the surface remains below the saturation temperature (dew point) and as long as vapor can permeate to the cold surface. The most obvious solution to this situation is to prevent the vapor from penetrating to the cold surface. This is readily done by placing a vapor barrier near the warm side of the wall.

Trouble from condensation within walls can be prevented, but it continues to exist for several reasons—either the problem was ignored during construction, or the real source of the trouble was misinterpreted and action was taken which actually increased the difficulty. It is a common fallacy to believe that moisture in building walls comes directly from the weather side. This is seldom true since the exterior finish of a wall is made to shed precipitation rather effectively.

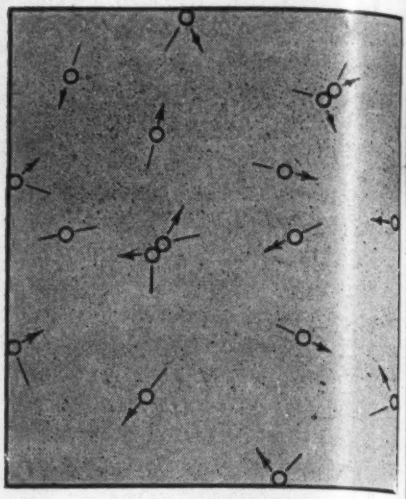
The modern tendency is to build tight houses which keep the rain out but also provide less ventilation for carrying away excessive vapor. It is also a modern tendency to build small houses; this boosts the occupancy ratio (persons per 1000 cu ft of volume), and tends to maintain higher vapor pressures within the house. Modern plumbing and appliances also contribute to boosting the vapor pressure. Better insulation contributes to the problem by virtue of the fact that the materials forming the exterior finish of an insulated wall are colder than similar materials in a wall without insulation. If insulation is added indiscriminately a dry wall may become a troublesome wall because of the vapor penetrating the insulation and condensing on cold surfaces. The judicious application of a vapor barrier can prevent and cure these troubles.

Moisture Control in Industry

Hygroscopic materials have an affinity for moisture and will absorb moisture vapor in a quantity which varies with relative humidity and temperature. Some of these materials will deliquesce or gradually dissolve and become liquid by absorbing moisture vapor from the air. In order to properly process these materials it is necessary to control both temperature and humidity. Where very dry air is required, dehumidification equipment is available for removing the moisture from the air. This equipment employs desiccant material which is capable of removing a very high percentage of the moisture vapor from the air passing through it. Many effective uses of the dehumidification drying process are found in industries such as pharmaceuticals, candy making, safety glass, steel alloys, and many other processes.

The ability of a desiccant to remove water vapor from the air is explained by the fact that the vapor pressure of the water in the desiccant is less than the partial pressure of the water vapor in the surrounding atmosphere. When humid air, or air to be dried, is passed through a bed of solid desiccant material, such as activated alumina or silica gel, there is a tendency for the vapor pressure of the water in the desiccant to reach equilibrium with the partial pressure of the water vapor in the air. If the desiccant has been properly activated so that the vapor pressure is very low, water vapor will be adsorbed from the humid air as it passes through the bed of desiccant. The process is reversible and the desiccant can be reactivated by raising its temperature until the vapor pressure of the adsorbed water exceeds the partial pressure of the vapor in the surrounding atmosphere. Water will be released by the desiccant. Equipment designed to utilize this characteristic of desiccant materials is used to maintain dry atmospheres where hygroscopic materials must be processed and quality controlled regardless of the weather conditions.

In many industrial processes (such as the production of precision parts and fine steels) it is vital to maintain a reduced vapor pressure to prevent corrosion. Relative humidity and corrosion of steel and other metals are directly related. Corrosion proceeds at a high rate at high relative humidity and much slower at a low relative humidity; in fact, at low relative humidity corrosion may be inhibited. Special rooms are constructed to enclose facilities for producing precision parts. Desiccant dehumidifiers are used to maintain low relative humidities in these rooms. The cost of dehumidification is more than offset by the reduced number of rejects, the material saved from corrosion, and the time saved by avoiding shutdowns due to humid weather.



When a ping pong ball strikes a wall and bounces back, it exerts a force on the wall. Likewise, a multitude of molecules striking the walls of a container exert a force per unit area called pressure

In recent years equipment has been developed for economically maintaining a dehumidified atmosphere for the preservation of military materiel. This method of preservation, in addition to maintaining an excellent condition of readiness, eliminates the need for heavy coatings and is much more effective in preserving precision parts and inaccessible parts of assembled equipment. The moisture vapor completely fills the space, but by reducing the vapor pressure below the critical point for corrosion, the material is effectively protected.

Similar to the removal of moisture vapor from the air is its removal from gases used in industrial processes. For instance, moisture present in natural gas will combine with the gas and form hydrates which give considerable trouble in transmission pipe lines. This trouble is avoided by drying the gas prior to pumping into the lines. The presence of moisture vapor in gases used in industrial processes may also lead to certain detrimental results. Where moisture vapor is undesirable it is removed prior to the utilization of the gas. Quite frequently very low moisture contents are desired, dew points below minus 100 F being specified. Special equipment is available for this.

PLANNING TO AIR CONDITION?

Electrical and Water Requirements

PRELIMINARY STUDY of the air conditioning needs of an office building, and an approximation of the electric power, wiring, and water requirements for various systems, is made possible by the data given here from a report on planned air conditioning for office buildings issued by the committee on education and research of the Building Owners' and Managers' Association of Philadelphia. This report was presented by C. Robert Cheyney, operating manager of the Fidelity-Philadelphia Trust building, at the 19th annual meeting of the Middle Atlantic Conference of Building Owners and Managers. This section completes publication of this report; the other parts appeared in the May, June, and July issues

THE FOLLOWING data are presented to enable an office building owner or manager to make a preliminary study of air conditioning requirements and to arrive at an approximation of the electric power, wiring, and water requirements for the various systems contemplated. Building characteristics, location of building, occupancy, lighting load, make and amount of equipment in use, as well as the individual usage of the equipment, all will influence and affect the resulting data.

Load Requirements

The basic assumptions used in this preliminary study are as follows:

Kind of building: Commercial or bank on first floor, offices on remaining floors.

Type of construction: Average, well constructed.

Number of floors: 15.

Area per floor: 12,000 sq ft net rentable area, plus corridors and elevator lobbies.

Total area: 180,000 sq ft net rentable area, plus corridors and elevator lobbies.

Building occupancy: 128 sq ft per person, 94 persons per floor, 1410 persons total.

Lighting: 3 watts per sq ft of net area.

Refrigeration tonnage: 325 sq ft per ton.

Electrical Demand

A central plant compressor for the entire building or per floor will operate at approximately 0.85 kw input per ton. Auxiliaries—consisting of fans, pumps, and evaporative condenser—will add approximately 30 per cent to this, or 0.25 kw per ton, making a total of 1.10 kw.

Using self-contained air conditioning units of 5 ton capacity each, the electrical demand, including economizers, will be approximately 1.2 kw per ton.

Using room coolers in the individual rooms of ¾ ton capacity each, the input per ton will be approximately 1.75 kw per ton.

Using window model room coolers in the individual rooms of 0.45 ton capacity each, the input will be approximately 1.9 kw per ton.

Total Tonnage Required

Per floor: 12,000/325 = 36.92 tons.

For entire building: 180,000/325 = 554 tons.

Power Requirements

No attempt has been made to incorporate diversity in the usage of the individual pieces of the air conditioning equipment or its diversity with other parts of the building load. Diversity of operation of the self-contained units, room coolers, and window models may result in a decreased demand from the figures given, which are based on the maximum tonnage.

Central plant: 554 × 1.1 = 609 kw.

Self-contained 5 ton units: 554 × 1.2 = 665 kw.

Room coolers, ¾ ton each: 554 × 1.75 = 970 kw.

Window units, 0.45 ton each: 554 × 1.9 = 1,053 kw.

Water Requirements

One central plant for entire building, with cooling tower on roof: 0.05 gpm per ton.

One central plant each floor, with cooling tower: 0.07 gpm per ton.

Cooling tower on roof for entire building: 0.05 gpm per ton.

Five hp self-contained units, with cooling tower for each unit: 0.10 gpm per ton.

Cooling tower on roof for entire building: 0.05 gpm per ton.

Space Requirements in Building

The space required for the air conditioning equipment will vary greatly with the equipment used. The gross space indicated is intended to include not only the net space occupied by the equipment, but ample work space around the equipment as well.

Building characteristics, its location and occupancy, the lighting load, make and amount of equipment in use, as well as the individual usage of the equipment, are among the factors influencing and affecting the data needed to make a preliminary study of a building's air conditioning

The net space shown for self-contained units, self-contained with evaporative condensers, and for the console models is the net floor space only. Additional space around such units will be required for necessary maintenance of the equipment, but this may or may not be reserved as such, depending upon local conditions.

Central plant for entire building, with cooling tower on roof: 4 sq ft per ton.

Central plant, each floor including cooling tower: 8 sq ft per ton.

With cooling tower on roof: 6 sq ft per ton.

Five hp self-contained units including cooling tower: 4 sq ft per ton.

With cooling tower on roof: 2 sq ft per ton.

Console roof coolers: 4.3 sq ft per unit, 5¾ sq ft per ton.

The live loading per square foot in office buildings (above the basement floor) may be a factor to consider, as the permissible loading may influence the type of equipment that may be installed.

Electric Power Consumption

For central station systems where full air conditioning is employed and the wet and dry bulb temperatures are carefully controlled, the total annual consumption should be somewhere between 1000 and 1200 hours use of the total cumulative electrical demand of the equipment. For self-contained units, console and window models, the hours of use being dependent to a greater extent upon the individual tenants, no data are available at this time. The smaller the equipment, the lower the efficiency that may be expected; however, the diversity in operation and other factors as above noted may tend to equalize this to a greater or less extent.

The cost of electricity seldom is an influencing factor in determining the type of equipment to be used. A complete evaluation should be made of the first cost of the equipment, installation cost, maintenance, depreciation, obsolescence, and operating cost.

Substation and Wiring Facilities

Providing adequate substation and wiring facilities is one of the major problems and should be given careful consideration.

Substation

The substation capacity must be adequate to provide the power required by the air conditioning equipment. Considering the 15 story office building used as an example, the added substation capacity, based upon maximum tonnage, may be as follows:

Central plant, entire building: 609 kw, 640 kv-a.

Central plant, each floor: 609 kw, 700 kv-a.

Self-contained units: 665 kw, 780 kv-a.

Room coolers: 970 kw, 1385 kv-a.

Window models: 1053 kw, 1600 kv-a.

Wiring Facilities, Central Plant

Using one central plant, the compressor motors would be of sufficient size to warrant or permit the use of 2300 volt synchronous motors. These motors operate at 100 per cent power factor so that the current requirements are a minimum.

The remaining power for auxiliaries will be approximately 140 kw at 86 per cent power factor, or 163 kv-a. For a 220 volt, 2 phase circuit, the current amounts to 370 amp per phase.

If a central plant is installed on each floor, using 220 volt, 2 phase motors, the total kv-a becomes 700, and the current per phase approximately 1590 amp. If separate feeders are run to each floor, this will amount to 106 amp per phase per feeder per floor.

Self-Contained Units—
5 Tons Each

Total power: 665 kw, 780 kv-a.

Total current per phase, at 220 volts: 1770 amp, approx.

Current per floor, at 220 volts: 118 amp.

Room Coolers—¾ Ton Each

Total power: 970 kw, 1385 kv-a.

Total current per phase, at 220 volts: 3,150 amp, approx.

Current per floor, at 220 volts: 210 amp.

Each of these ¾ hp units in all probability will be connected to a 220 volt circuit. Since each unit will take approximately 8½ amp at 220 volts, not more than one unit can be connected per circuit unless each unit is independently and adequately fused or otherwise protected.

Window Models, 0.45 Ton Each

Total power: 1053 kw, 1600 kv-a.

Total current per phase, at 220 volts: 3630 amp, approx.

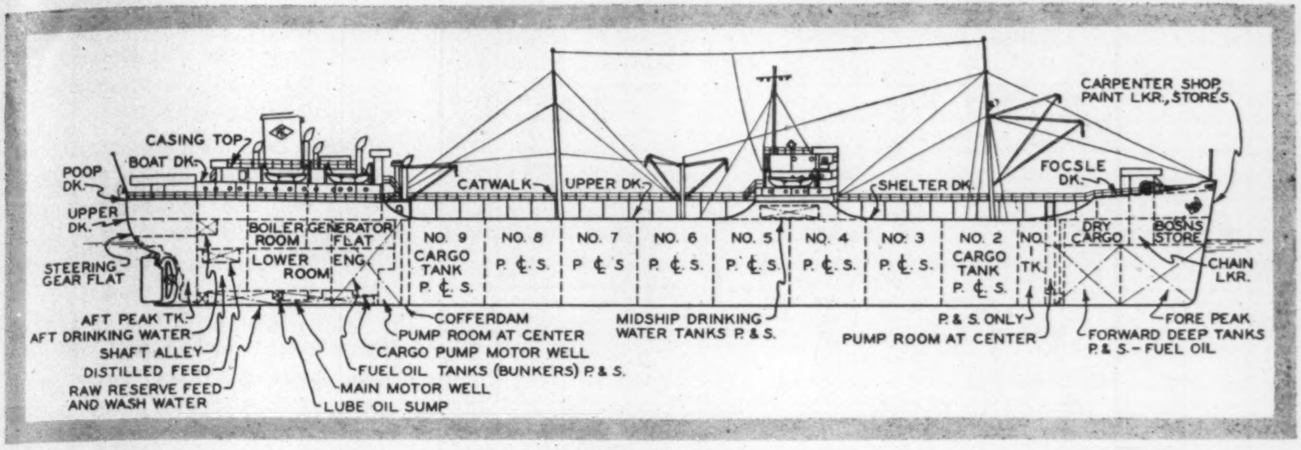
Current per floor, at 220 volts: 242 amp.

These units will be wired for 110 volts. Each unit will draw approximately 12 amp. Not more than one such unit may be connected to a circuit unless each unit is independently and adequately fused or otherwise protected.

ARMY NEEDS CIVILIAN ENGINEERS FOR OVERSEAS

Civil, sanitary, electrical, mechanical, refrigeration, and air conditioning engineers are needed to fill overseas positions with the U. S. Army Engineers. Positions are available at Guam, Philippine Islands, Okinawa, Japan, Korea, and in the Caribbean areas. Salaries range from $3306 to $8875. Housing for dependents is not generally available.

Applications should be made to Civilian Personnel Branch, Office of the Chief of Engineers, Building T-7, Gravelly Point, Va. Applications should include completed form 57, U. S. Civil Service Commission, in duplicate, copies of which can be obtained at local post offices.


CASING TOP
BOAT DK.
POOP DK.
UPPER DK.
STEERING GEAR FLAT
BOILER ROOM
GENERATOR FLAT
LOWER ENG. ROOM
CATWALK
UPPER DK.
NO. 9 CARGO TANK P. ℄ S.
NO. 8 P. ℄. S.
NO. 7 P ℄ S
NO. 6 P. ℄. S.
NO. 5 P. ℄. S.
NO. 4 P. ℄. S.
NO. 3 P. ℄. S.
NO. 2 CARGO TANK P. ℄. S.
NO. 1 TK.
SHELTER DK.
FOCSLE DK.
CARPENTER SHOP, PAINT LKR., STORES
DRY CARGO
BOSNS STORE
CHAIN LKR.
AFT PEAK TK.
AFT DRINKING WATER
SHAFT ALLEY
DISTILLED FEED
RAW RESERVE FEED AND WASH WATER
COFFERDAM
PUMP ROOM AT CENTER
CARGO PUMP MOTOR WELL
FUEL OIL TANKS (BUNKERS) P. & S.
MAIN MOTOR WELL
LUBE OIL SUMP
MIDSHIP DRINKING WATER TANKS P. & S.
P. & S. ONLY
PUMP ROOM AT CENTER
FORE PEAK
FORWARD DEEP TANKS P. & S. – FUEL OIL

Outboard profile of the tanker. Note the location of the forward fuel tanks with respect to the dry cargo space. The access trunks to these tanks ran up to the weather deck. Also note the location of the aft fuel oil tanks with respect to the upper deck quarters

Design Engineer Reports on Operating Experience

By John H. Clarke

ABOUT A WEEK out of Panama, we got around to removing the air heaters in the ventilation heating system for the aft quarters. There were no bypasses around the heaters and the air capacities of the two systems were hardly adequate for this ship. These capacities had been further reduced by providing a fine mesh (¼ in. mesh, 3/16 in. openings) for the fan room trunk inlets. We did not need the heaters for the rest of the trip—five months.

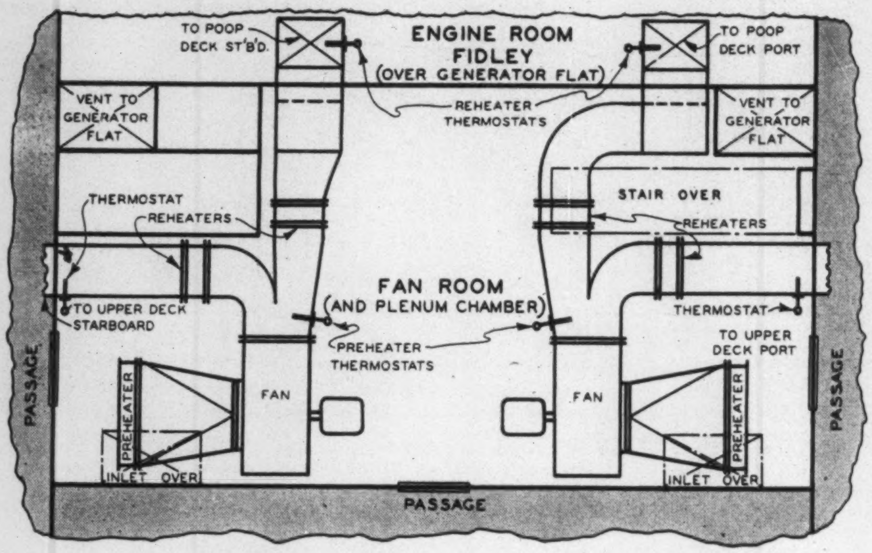
The ventilation heating system for this ship was of the central type with one fan system for the port side and one for the starboard. For this class of tankers, several variations were used. On some ships the preheater (tempering) and reheater were located ahead of the fan, the former being controlled by an outside air thermostat to maintain approximately 60 F; or in the majority of cases to provide freezing protection by opening the preheater wide as the outside temperature dropped from 35 to 32. The reheater was controlled in most cases by a ductstat which was reset by an outside compensating control, to adjust the reheat temperature as the temperature outside dropped from 70 to 0 deg. For the reheaters this was the best control.

But the use of one reheater for each system was unfortunate, as it was impossible to balance the system for both heating and ventilation because of the type of spaces served. Some of the rooms (see sketch) were over the oil bunkers which were kept at 110 F; others on the same deck were farther aft but still got a considerable amount of heat from the boiler room casing which ran as high as 150 F in hot weather. None of the spaces on the upper deck had portholes, and the psychological contribution which such a closed space makes toward a feeling of "stuffiness" should not be underestimated. On the other hand, the quarters on the poop deck had portholes and better "through" circulation which tended to keep these spaces cooler. Thus, no one system of temperature control could come close to satisfying the requirements for all spaces.

Controlling Reheater Temperature

On some ships, the mistake was made of controlling the reheater temperature by a room thermostat *located in the fan room immediately under the outside air intake trunks.* (The fan room is used as plenum chamber.) Needless to say, this system was a complete failure.

HOW DO DESIGNS perform in service? How is the equipment actually operated? The answers to these questions were among the author's objectives when he (a marine design engineer by training and profession) shipped on a tanker as junior third assistant engineer. By the time his seagoing phase was completed (he's now back on land as a design engineer with the Standard Oil Co. of Indiana) he got plenty of practical information on piping, pumping, heating, ventilating, and other subjects. His comments and observations on much of his experience are continued here from our June issue—a lot of what he found out applies not only to marine work but to design, operation, and maintenance of mechanical equipment in plants and buildings as well



Fan room for the ventilation heating system for the aft deck house

On our ship the preheater was ahead of the fan and controlled by a thermostat following the fan. *Two* reheaters were provided for *each* fan system, one for the upper deck and one for the poop deck. This was an improvement over other designs of this type, but it was still impossible to balance the upper deck system for ventilation heating without overheating the rooms over the fuel tanks. In addition, the system was not balanced properly, and the reheater thermostats were installed in the duct to maintain a set *constant* temperature.

Outside compensation should have been provided to prevent overheating with changes in temperature—such as cold nights and warm days. Keep in mind that 24 hr a day someone is trying to sleep on board ship. No thermometers were provided in the ducts, so the preheat and reheat temperatures could not be determined. The main duct splitters (adjustable) were not marked and there was no adequate means of determining when they were closed or open, or how they worked. The outlet balancing dampers were merely pieces of sheet metal fastened to the bottom of the branch duct, with no means provided to hold them in a set position.

In heating weather we tried to keep the fan room locked, but in warm weather the fan room doors had to be opened to get adequate air in the system. Someone was continually tampering with the main balancing splitter for the ducts supplying the two decks. Additional unorthodox "balancing" was accomplished by removing the outlet registers for more air or stuffing towels and books in the branches if less air was desired. No air filters were provided for the fan inlets, and as a result the fans and heaters were heavily coated with dirt and dust. The preheaters, which had 1/8 in. fin spacing, were almost closed up from the oily dirt and dust. Thus it can be easily understood why it was so desirable to remove the heaters. Dummy sections were installed in lieu of the reheaters. The preheaters were simply removed.

How to Improve Ventilation Heating

For the remainder of the trip, most of the crew slept outside on the deck when the weather permitted (and sometimes when it didn't). During the hottest weather, the upper deck quarters became unlivable as far as sleep was concerned. Army cots were provided on board for those who wished to use them for deck sleeping. But the captain was sometimes overly fastidious with respect to such cluttering up of the decks, and now and then a cot or two would disappear —in the language of the brethren, they were given the "deep six."

From the above it may be concluded that the design, installation, and balancing of these ventilation heating systems was very poor. More zones should have been provided, the volumes increased considerably, bypasses provided around the heaters, and outside compensation provided for the reheater controls. Filters and thermometers should have been installed and the complete system should have been properly balanced.

These ships do not represent the best of maritime design as far as ventilation and heating are concerned, but the lack of careful engineering design and good installation and testing are typical of the marine industry. The Maritime Commission had had, and still does have, some good ventilation engineers. Considerable progress has been made in ventilation design. But it is extremely difficult to sell the shipyards, the inspectors, and many of the operating personnel on the importance of well designed and balanced ventilation systems. Consequently many details are overlooked and the balancing—if done at all—is of a most superficial nature.

Two testing methods are in prominent use. For the first, you hold your hand over the outlet. If air is coming out, it's all okeh. The second method is more scientific. You use instruments. It consists of a routine test whereby you put the desired volume in the first column of the data sheet, then write in the test volume required in the second column. After this you go out on the ship and "test" for the data in the second column. One gentleman observed using this method was taking anemometer readings with the palm of his hand all but covering the instrument. But the volume recorded was "right on the button." Another ship was "balanced and tested" and the test readings came out within 10 per cent for every outlet. There wasn't a balancing damper on any system on the ship. It's remarkable what you can do with a little imagination.

[The above remarks do not apply to the Navy, which was fortunate in having the services of a large staff of eminent air conditioning engineers, who were able to revamp completely the ventilation, heating, air conditioning, and testing standards of that department.]

Water Doesn't Drip Straight Down

In disconnecting the ventilation air heaters mentioned above, the condensate lines were not immediately plugged (the location of the most convenient unions happened to follow the shutoff valve). Condensate backed up through these pipes and filled the fan room with about 2 in. of water. Somewhere there was a leak in the deck, and water dripped down through the insulation (under the deck) and onto the main switchboard. Consequently we got the water out of the fan room in a hurry and plugged the drains.

This brought up a very interesting point with respect to the switchboard design. These switchboards were made up in sections, each with a drip-proof top. But the adjoining sections on top were not provided with any closures, the sheet metal being butted together with no fastening other than that each section was bolted to the deck and to the next section. Whoever designed the board probably overlooked the fact that on a rolling ship water does not drip straight down with respect to the equipment. Consequently, the water that was dripping down from the deck above ran over to the cracks at the butt joints and dripped through—at various angles, depending on the roll of the ship. Each of these switchboard sections should have been flanged up, and provided with a closing piece of sheet metal over the flanges. With more water flowing the leak could have been serious. We never did find the leak in the deck.

The above—while serious—is really only a minor criticism of the switchboard. Despite the hundreds of switches, relays, and other automatic devices, this board gave us practically no trouble at all and was probably the most reliable piece of equipment on the ship. We did, however, gripe about one item. Some person with a weird sense of humor had located the kwhr meter for propulsion power behind the main control cubical. It had to be read every watch. To read it, it was necessary to go behind and all the way across the length of the switchboard and look through a window in the access door to the cubical (the door with the interlock on it that gave us trouble when we left Panama). On a rolling and pitching ship, one does not relish frequent trips behind a high voltage panel where there is just barely room to squeeze through. On later ships than ours this oversight was corrected.

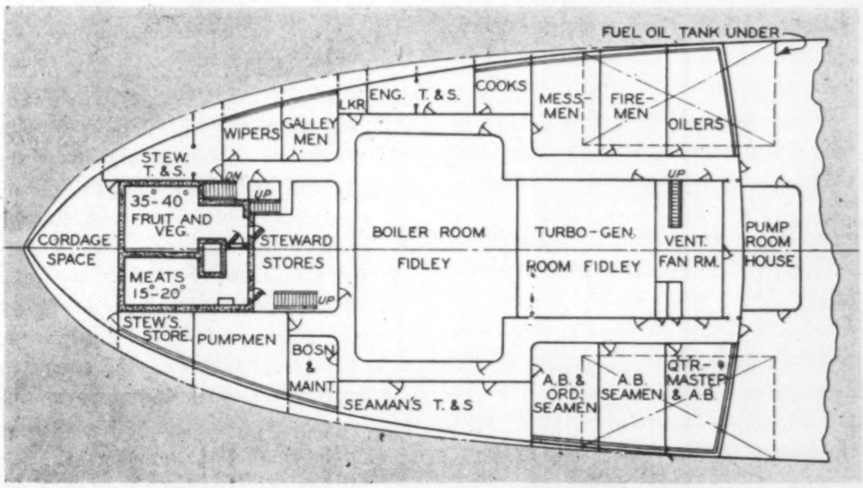
The 21 day trip from Balboa to Wellington was long and tiresome. We had very pleasant weather at first, but in the vicinity of Pitcairn Island, about halfway, it became squally and rough, and the weather continued this way until we arrived at Wellington. We passed in sight of Pitcairn Island and our radio operator had quite an animated conversation with the radio operator on the island. The Islanders were very friendly and offered to bring out fruit to the ship if we would heave to long enough for them to make the trip. However, the captain decided not to stop as we were already well behind schedule. The island looked very small and its abrupt cliffs certainly did not make it appear to be inviting or habitable. Apparently the only approach is on the north side and we passed to the south.

Engines on "Standby"

During this squally weather we ran into a number of storms where for a matter of five minutes to half an hour the visibility would be very poor. Despite the fact that before and after the rain you could see vast portions of the surrounding ocean, the captain always put the engines on standby. This meant that someone had to be at the throttle for instant response to a signal. Sometimes we would be on standby for an hour or more. This considerably restricted our movements in the engine room and made it harder to check the equipment.

On one occasion I ventured as far as the fire room door to check an item on the boilers. The oiler was below making a round. At this moment we got a bell from the bridge. I charged around the end of the main turbine as fast as one can on a rolling ship and slide in to "home plate," grabbing the engine order telegraph and the throttle at the same moment. This mad dash couldn't have consumed three seconds, but I got a severe reprimand from the bridge for even this delay. Of course, the captain was entirely correct, inasmuch as we were on standby. The only thing that tickled us was that every time his corns hurt or the radio predicted a storm in Timbuctoo, the captain put the engine room on standby; most of the time, we didn't even change speed. This, incidentally, did nothing to improve the traditional strained relations between the chief and the captain.

We arrived at Wellington on a



The upper deck, aft, showing the crew's quarters. The upper deck (usually called the main deck on other types of ships) is over the machinery spaces and under the poop deck, on which were located the engineering officers' and stewards' quarters, the galley, and the messrooms. None of the upper deck spaces were provided with portholes. Note the quarters port and starboard over the fuel oil tanks. The oil in the latter was kept at 110 deg, thus making the spaces above insufferably hot during warm weather and creating a difficult heating and ventilating problem. The temperatures in the refrigerated spaces are the usual temperatures for marine design, although there has been some controversy over reduced temperatures. The writer is inclined to favor lower temperatures, but there was nothing conclusive that could be ascertained from the trip in this respect. There was considerable spoilage, but usually from other causes than the holding temperature. More modern ship designs provide for dairy and fish rooms also, all spaces opening from a thaw room

beautiful sunshiny morning and proceeded to the unloading dock to pump our cargo ashore. The week before arrival we had put on the cargo oil heating system and had raised the oil temperature to 90 deg. This was cold for pumping temperature and 120 F would have been closer to normal for this heavy fuel oil (No. 6 or lower), but the captain insisted that it would be dangerous for it to go any higher. The engine room only gave the deck crew the steam they wanted, so it was none of our business unless the pumps or motors were endangered.

The actual procedure for pumping did not go too smoothly. The cargo should have been pumped from forward to aft, keeping one suction open on each pump, particularly when a tank got low. On many ships they stripped into the No. 9 center tank, thus permitting the main pumps to operate and thereby speeding up the discharge. We just stripped. So the pumps were frequently losing suction, and this considerably increased the time required to pump out the tanks.

Someone tested the steam stripping pump by discharging water overboard. When the pump was used to strip oil, he forgot to close the overboard valve and we paid a $500 fine for spilling oil into the harbor. (They had a clean harbor at Wellington and they intended to keep it that way.)

While pumping at the docks, it was still necessary to keep the cargo oil heating system in operation. This system required a very high capacity at maximum operation and under port pumping conditions was still using about 10,000 lb per hr of steam. The condensate from the heating coils came back to an atmospheric inspection tank, down to an atmospheric drain tank, and then back to the condensate system.

The drain tank pump was not sized to take the full cargo heating capacity, so a drainer (float type trap) was provided to take either all or part of the condensate from the tank. The drain tank pump operated off-and-on and was controlled by a float switch. The drainer was not operating properly (probably from scale) and would not close sufficiently to prevent the condensate from pulling out. The drainer was connected so as to drain to either the main or auxiliary condenser. We set the drainer stop valve so that the capacity was just under that of the cargo heating system. The drain tank pump then handled the rest of the condensate automatically.

But since the capacity of the cargo heating was changed from time to time, it was necessary to keep a close check on the drainer and tank to be sure that it didn't pull out; the drainer was discharging to the auxiliary condenser in this case. One of the engineers got careless and the tank did pull out, with the result that the vacuum was lost on the auxiliary condenser. But because the main unit was only being used for pumping and not much power was being used, water was being recirculated from the condensate system from the same manifold back to both condensers to keep the air ejector condensers properly cooled. When the vacuum was lost in the auxiliary condenser, the main condenser then pulled air through the recirculating manifold and the vacuum was lost on it also. Closing the drainer discharge valve of course corrected the trouble.

Productivity Is Key to Future Welfare

Backing up manpower with machine power is the secret of America's spectacular achievements in both wartime and peacetime production, says the Twentieth Century Fund's survey of America's Needs and Resources, which shows that in 1944 we turned out nearly 27 times as much in goods and services as we did in 1850, with a labor force only 8½ times as large but using 343 times as much mechanical energy in doing so.

"Productivity is the key to future welfare," says Dr. J. Frederic Dewhurst, economist of the fund, who directed a staff of 20 experts in the 3½ year job of compiling the survey and did the major part of writing and editing the report. "The only way to raise the ultimate ceiling on production, which is manpower, is through further increases in output per worker and per manhour."

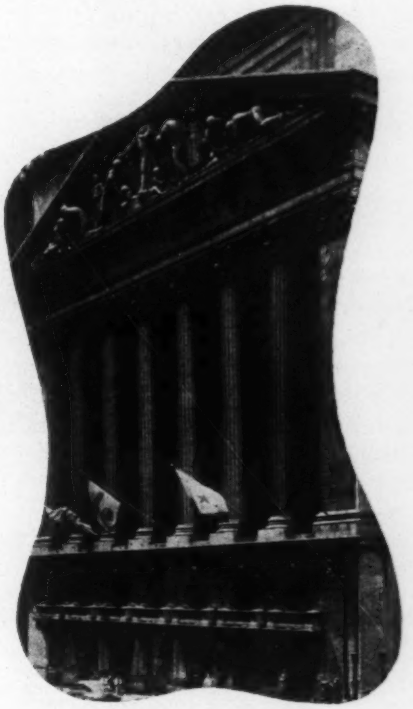
Pointing to the use of machines and inanimate energy as the central factor in this process, Dr. Dewhurst says, "Over the long run the 'efficiency' of the individual worker is a minor element in the productivity of the labor force. The most energetic and skillful shoemaker working long hours with the hand tools of a century ago could not remotely approach the productivity of today's semi-skilled operative, working with the aid of automatic, power driven machinery."

In making the survey's main estimates of what the total output of goods and services might be in 1950 and 1960 if our economic system is operated at high levels, Dr. Dewhurst has assumed that productivity will continue to increase at the average rate of increase for all the decades between 1850 and 1940. This average is 18 per cent and, using it as a base, the survey estimates 1950's total output of goods and services in the United States at $177 billion and 1960's output at $202 billion. These estimates are in terms of 1944 prices, which are about 15 per cent below present levels. However, increase in productivity, or output per man-hour of work, has shown great variation in the past. It amounted to 42 per cent in the decade 1930 to 1940 and 21 per cent in the decade 1920 to 1930.

Dr. Dewhurst says, "If we could increase output per manhour at the average rate of the two decades before the war, which seems quite possible, we could turn out a gross product of nearly $200 billion in 1950." On the same basis, he estimates a total output of $249 billion would be possible in 1960.

AIR CONDITIONING

the New York Stock Exchange



Donald A. Kepler, Chief Engineer, Describes Plans for Modernization

IN REVIEWING THE air conditioning istory of the New York Stock Exhange, it is apparent that stock rices were not the only things in he board room that were subject o frequent change. After the annex ad been built to provide additional loor space, a number of alterations were made to speed up the actual rading process. One change in articular, which had to do with he pneumatic tubes, reacted most nfavorably on the air distribution cheme. A pneumatic tube system, oasting "97 separate lines" had een included in the mechanical quipment of the old building. The ubes were not extensively employed n regular trading operations until fter 1922, when new motor driven lowers for the tube service were installed. From this time on, additions to the 1¼ in. pneumatic tube lines kept the tube mechanics busy.

The space below the board room, where formerly the exhaust duct work held complete supremacy, became the scene of a conflict between tube lines and ducts. The space was only about 3 ft in depth so the difficulty of retaining the large ducts and squeezing in the many new tube lines frequently resolved in a "push and shove" scuffle—in which the tube lines won out. It was presumably easier to rationalize the flattening of a duct than it was to run the tubes around the long way. While this sort of thing interfered with the balance of air quantities, no apparent harm was done until 1928, when new trading posts were installed (see page 90).

The 20-odd round posts were removed, one by one, and 12 new horseshoe posts were installed. All the work was done over weekends or holidays so as not to interfere with normal business. The trading post moves had an unfortunate effect on the exhaust system, for the flues that went up to each of the old posts were simply forgotten and the connecting ducts were partially removed. The shift of the tube lines from the old post locations to the new positions was scheduled in such a way that there was no time to consider the effect of mutilating the ducts. Only the exhaust from the telephone booths remained intact. Since this crippling of the exhaust ductwork was a gradual process, the effect was not immediately apparent, and if it had not been for the unprecedented activity on the "floor," it might have escaped notice altogether. However, considerable harm had been done. Although it is often considered acceptable planning to give exhaust layouts only second-rate prominence, the Stock Exchange system was certainly not at its best under these conditions. One compensating factor was the exhaust action through the board room floor around the point where the tube lines passed through. The broken off ends of the ducts continued to

DON'T EXPECT an air conditioning system to operate itself. It needs the personal touch, and responsibility for success is ivided between the designer and the operator (to say nothing f the manufacturers of the equipment and the installer). This as been brought out in Mr. Kepler's three articles on the air onditioning experiences of the New York Stock Exchange. The irst (in April) described the original system, the second (in une) reviewed the replacement of the original system with he one now in use, and the third (this month) tells of the mbitious plans for bringing the air conditioning of this important building up-to-date.... Mr. Kepler joined the New York tock Exchange Building Co. as ventilating engineer in 1937, nd in 1942 was assigned the duties of chief engineer and hose of project engineer for mechanical plant and equipment

draw from the hung ceiling space and an exhaust plenum effect was obtained.

Additional Building Supplied

In 1928, the trading area again became congested and the Stock Exchange, in anticipation of another new building program, purchased two additional buildings to the south of the old building. Several floors of one of these, the old Commercial Cable building, were promptly converted into a bond trading area. While this was to be a temporary move, to be used only until comprehensive plans for the new structure could be completed, air conditioning was demanded. Cooling for this unit was supplied from the central plant in the old building.

The cooling unit consisted of a bank of copper "radiators"; these were of the fin type commonly used for indirect steam heating. In other respects, this system was similar to those installed in 1921; it included a reversing damper, and omitted provisions for winter humidification.

Apparently an ammonia leak developed in the brine system shortly after the coils were installed for they lasted only a few seasons. At that time they were replaced. It was in 1933 that this change was made, and at the same time the idea of recirculation was adopted. Both an outdoor air and a return air bypass were provided. It is of interest to note that this installation was the first instance of the use of recirculated air in any Stock Exchange system. It was also the first system which included complete summer and winter controls.

No doubt recirculation would have been employed earlier had it not been for the insistence of some of the members on having "an all-fresh-air" supply. But owing to the intensely crowded conditions in the trading areas, the old carbon dioxide fear could not be easily discredited.

When the stock quotation bureau was relocated on the 15th floor of the new building in 1933, an air washer unit was selected for the air conditioning. Chilled water was provided by a shell and tube exchanger which was tied into the high rise brine circulating system at the fifth floor. The controls which adorned the washer unit were complex and they defied all attempts (including those of accredited service men) to keep them in adjustment.

One of the principal reasons for air conditioning the stock quotation bureau was to keep the extensive wiring devices and teleregister equipment clean by eliminating the need for open windows. Inasmuch as these rooms were nearly airtight and were not provided with any means of air relief for inbetween seasons, comfort conditions were far from satisfactory. The difficulty was temporarily rectified after those in charge had been convinced that several partially open windows would not cause dust and dirt to be brought in. A more permanent solution is being included in the plans for a general revision.

Design for Three Seasons a Year

From the operational viewpoint, this installation serves to illustrate two unsatisfactory design features. First, an elaborate control system is no guarantee that the air conditioning unit is going to perform with a minimum of attention; second, an air conditioning system must be designed for the three seasons of the year.

The three seasons are: summer, winter, and inbetween. Until recently, air conditioning to most people has meant air cooling. Lately, people have become conscious of the advantages of winter air conditioning—or, in many cases, the lack of it. The inbetween season is the one that usually escapes notice; yet wherever there is a large internal heat gain, the inbetween season is just as much of a problem, and it is about twice as long.

In 1935 the Stock Exchange had an opportunity to experiment with one of the controversial issues of the day, "central plant vs. unit system." A number of the administrative offices were moved into one of the recently acquired buildings. Two small unit systems were installed, one a 1½ ton "Freon" unit for a single office, and the other a 5 ton unit for an important committee room.

The most significant feature of these installations was the control systems. The control systems were not well suited to the performance requirements of the units and the cost of the controls was out of proportion to the cost of the complete installation.

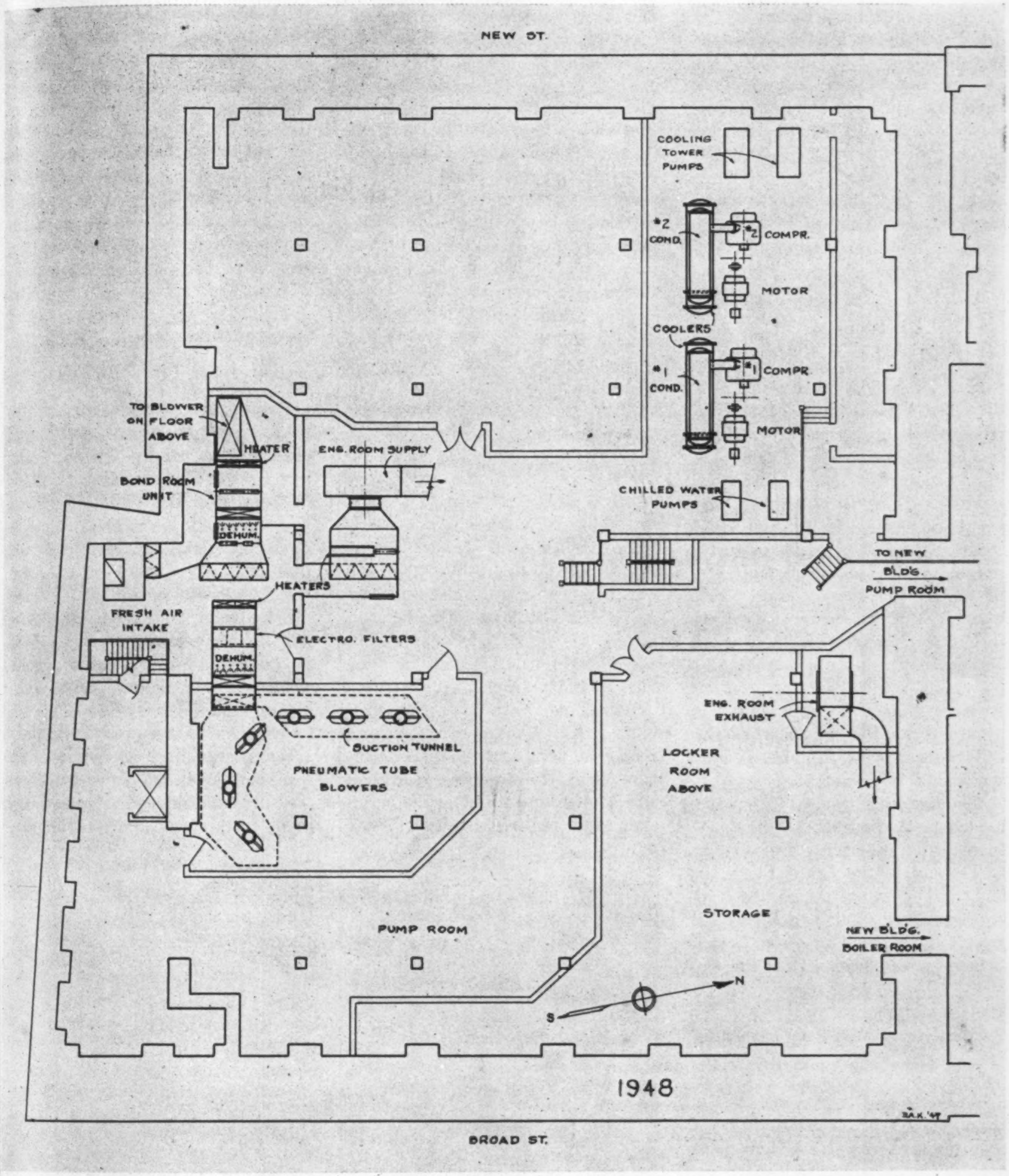
These systems were put in at a time when many air conditioning men were attempting to make their elaborate systems perform unnecessary tricks. Their magic, however, was too much akin to "wishcraft" to make a hit with the customers. Such systems were so "scientifically" planned and so impersonal that no amount of persuasion or cajolery could keep one Btu on friendly terms with another. In the instances just mentioned, one feature of the winter control was the use of modulating dampers to regulate the heat output of enclosed window radiators. Invariably, the room would overheat and before temperature conditions could level off, the control cycle would work over into the summer sequence and demand refrigeration. With outside temperatures in the 40's, this was absurd. By "gagging" several of the instruments, the system was made to perform in a fairly satisfactory manner.

Fortunately, the fad for "over-instrumenting" control systems and designing them without regard for the operating properties of the particular system went out of vogue about this time.

Winter Conditions Cause Complaints

1938 and '39 were poor years for the Exchange, and the lack of activity gave the floor members a chance to think about their other troubles. And they had troubles, for winter ventilation seemed to be getting progressively worse. Winter draft complainers in the board room were becoming more and more vehement.

A program intended to rectify the more obvious defects of the system and at the same time mollify the members was implemented. A few changes were made in the supply ductwork in an attempt to obtain a more equitable distribution, and the exhaust plenum was inspected for leaks. No worthwhile improvement was realized, yet, from the months of continual study, a few operating tricks were devised that permitted the ventilation me-


NEW ST.
COOLING TOWER PUMPS
#2 COND.
2 COMPR.
MOTOR
COOLERS
#1 COND.
1 COMPR.
MOTOR
CHILLED WATER PUMPS
TO NEW BLD'G. PUMP ROOM
TO BLOWER ON FLOOR ABOVE
HEATER
ENG. ROOM SUPPLY
BOND ROOM UNIT
DEHUM.
HEATERS
FRESH AIR INTAKE
ELECTRO. FILTERS
DEHUM.
SUCTION TUNNEL
PNEUMATIC TUBE BLOWERS
ENG. ROOM EXHAUST
LOCKER ROOM ABOVE
STORAGE
PUMP ROOM
NEW BLD'G. BOILER ROOM
N
S
1948
B.A.K. '47
BROAD ST.

The arrangement of equipment for the Stock Exchange's new system. The respective floor area requirements of the proposed new refrigeration plant as compared with the present plant are 2.1 sq ft per ton (and room to spare), with the centrifugal machines as compared with 6.7 sq ft per ton for the ammonia equipment. Owing to the uncertainty of delivery of materials, it was necessary to select a machinery room location that would permit the old plant to remain intact until well into '48. The old dynamo room was chosen since the generators have been idle for nearly 20 years and, as a standby plant, it was of insufficient capacity to justify its retention. Another advantage of this site is the proximity of the proposed a-c vaults on New street. The drawing shows the revamped bond room unit and a new dehumidifier unit for the pneumatic tube air, both located in the outdoor air intake. For years, the tube blowers have been discharging a total of 15,000 cfm of compression heated air into the trading rooms. The old 1902 supply unit for the sixth, seventh and eighth floors is not shown since it is to be discarded. These floors will be individually conditioned from units located on the upper floors

chanic to shift the location of the draft and so prevent it from becoming increasingly violent. This involved manipulation of the steam supply to the large window radiators, making it possible to alternate the downdraft from one side of the room to the other. This may seem to be an insignificant accomplishment but as an expedient it had a salutary effect on the comfort of the occupants.

Summer Complaints Become Problem

Up to this time, there were few summer complaints but in 1939 they, too, became a problem. The bunker coils in the board room system became so corroded that failure of a majority of the coils was imminent. Since this bunker was composed of nearly 80 individual circuits, the failure of one or two a season in previous years had been of no serious consequence. Now that eight or 10 of them at a time had to be shut off (repairing them was out of the question), the problem was a serious one. The need for replacements was apparent but everyone felt that at the time the coils were replaced, the entire system should be revamped.

The Exchange was not prepared to undertake that job at the time. Instead, arrangements were made to recirculate the board room air and thereby reduce the cooling load on the system. This proved to be a relatively simple job and, as a temporary measure, it had the desired results. As happened in so many instances, by the time serious thought was directed toward major air conditioning improvements, wartime problems made the floor members forget their ventilation troubles. In 1945, however, the air conditioning project was launched.

Ambitious Plans for 1948

The Stock Exchange now has ambitious plans calling for a complete air conditioning revision by 1948. Integration is the keynote of the program. Integrating the overall system layout—adapting the proper conditioner to the proper space—will eliminate the multiplicity of alien taps that now rob the larger systems of their design air quantities. Integration of the new refrigeration plant will find new centrifugal compressors, each operating as a unit with its own cooler and its own condenser. A cooling tower will be included in the refrigeration plant equipment. The Stock Exchange is confident that its consulting engineers will convert this broad program into a reality of modern air conditioning.

Aside from the remodeling of the many present units, the conditioning of many new spaces will be included in the program.

The air units which in years past have been indiscriminately tapped to supply cool air to a nearby office or to special committee rooms will be free to operate independently. When originally installed, some of the systems had more than adequate capacity and the expense of separate systems could not be justified. While several small taps meant little to the overall performance of a system, the operating schedules became so complex that frequently a 100 ton unit had to be kept in service five or six additional hours every day for the benefit of a "5 ton" committee room.

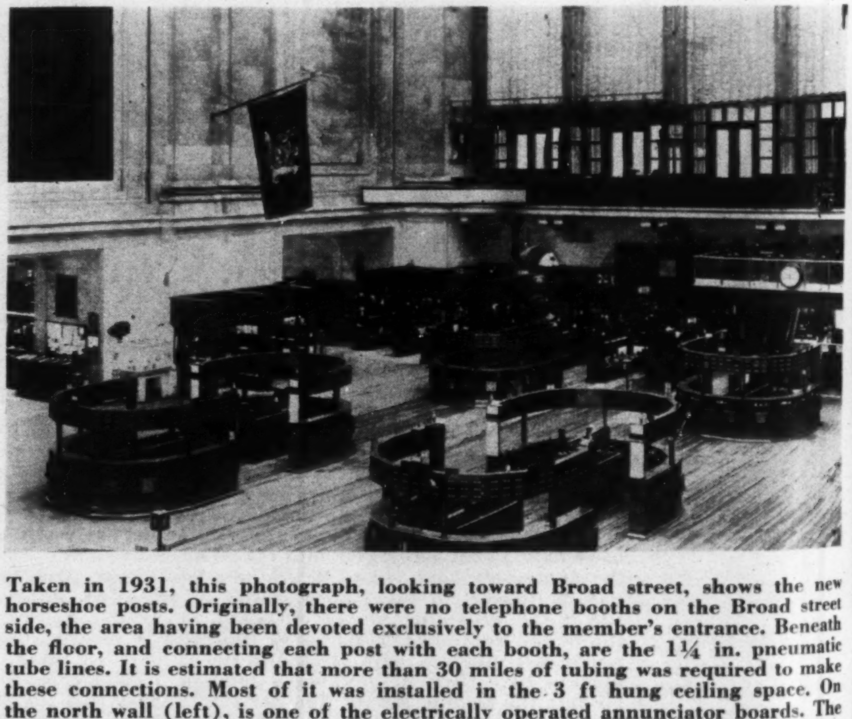
Individual units will be provided for the board of governor's room, the fifth floor quotation company plant, the sixth floor executive offices, the seventh floor luncheon club, and the eighth floor Stock Exchange departments. The majority of these units will be recirculating units, served from a common dehumidifier apparatus.

First, the dehumidifier units for the existing systems will be revamped, since the cooling coils are the current air conditioning bottleneck. Next in the program will be the installation of the new units. At the same time work will proceed on the new refrigerating equipment and the cooling tower. Finally, the distribution systems for the board rooms will be revised.

Three 415 Ton Centrifugals

Plans for refrigerating equipment show two 415 ton centrifugal compressors driven by slip ring motors. A new a-c service will be brought into the building and it will have sufficient excess capacity to accommodate a third 415 ton unit, as well as spare capacity for the future conversion of existing d-c lighting. With the third machine, refrigerating capacity will be adequate to air condition completely the principal Stock Exchange buildings.

Since there are many occasions when air cooling is required for the board room only, two machines were chosen instead of one large one. In this way, the machine out-



Taken in 1931, this photograph, looking toward Broad street, shows the new horseshoe posts. Originally, there were no telephone booths on the Broad street side, the area having been devoted exclusively to the member's entrance. Beneath the floor, and connecting each post with each booth, are the 1¼ in. pneumatic tube lines. It is estimated that more than 30 miles of tubing was required to make these connections. Most of it was installed in the 3 ft hung ceiling space. On the north wall (left), is one of the electrically operated annunciator boards. The broker's number is flashed by his telephone clerk, summoning the broker to receive orders from customers

put can be better regulated under low load conditions, and further, in the event that one compressor fails, the board room can still be cooled.

A new chilled water circulating system is in prospect. Since the operating temperatures will be above 40 F, new chilled water pumps will replace the present brine pumps but, instead of the high and the low rise systems, there will be only one system. In all probability, the exchanger for the air washer unit can be eliminated and the chilled water pumped directly to the 15th floor.

The proposed cooling tower is an innovation for the Stock Exchange. Past attempts to find a suitable location for a tower anywhere on the old or the new building had failed. The location finally selected is the Broad street tower of the Commercial Cable building. This is one of the buildings which was to have been demolished but could never be spared long enough to allow a new structure to be erected in its place. Novel features of construction are being incorporated into the cooling tower design, since it is to be a washer type tower built entirely within the present building structure. Actually there will be two towers, one on each of two floors.

First Step in Plan Completed

The first step in the rehabilitation plan has been completed; this provided the board room with a new air unit to replace the almost worthless bunker coils. While there remains much to be done with the board room supply and exhaust systems, replacing the air unit brought about a considerable improvement in the board room. For the first time, it has been possible, by dew point control, to regulate the summer and the winter humidities.

Instead of the two supply fans in parallel, one new fan was installed. This obviates the tendency of one fan to hog the load. In a performance test of the old fans, made in 1939, one fan was found to be handling 41,800 cfm while the other (an identical fan) supplied only 14,000 cfm.

Wetted fin coils provide cooling and dehumidification in the summer, and the sprays furnish humidification in the winter. Other features of the unit are electrostatic filters, face and bypass dampers, and a comprehensive yet simple control system. The board room exhaust fan was retained, but as a return air fan, and it now has a three way discharge: (1) to the roof outlet, (2) to the outdoor air intake, and (3) to the bypass connection. No preheaters were provided, but return air heaters were furnished in the bypass duct.

Operation and Maintenance

Owing to the prevailing material shortages, the ammonia refrigerating plant will be retained until the 1948 season and, with it, the old brine system. This has presented a touchy maintenance problem since tests of the brine in recent years have indicated the presence of small quantities of ammonia. Efforts to locate the leak have met with failure. Realizing the potential menace of ammonia on the new copper dehumidifier coils, a daily checkup is made of the pH value of the brine in order that it may be corrected when necessary. A hydrochloric acid treatment is used to avoid bringing down into the brine coolers a large quantity of sludge from the piping, which would seriously reduce the heat transfer capacity. The acid treatment has a tendency to produce iron salts at the expense of the pipe, but as yet this is occurring on a small scale.

With the proposed new refrigerating equipment, the problems of operation are expected to be simpler. No doubt it will be possible to revert to one man for starting and stopping the machines. While two men may be normally assigned to the refrigerating plant, starting before the regular day watch and shutting down after normal hours can be arranged without scheduling the early arrival of an engineer's helper.

With refrigerating plant maintenance reduced to the cleaning of condensers—and periodic cleaning of coolers — there will be a substantial saving in direct labor. Compare, for instance, the job of cleaning the present double pipe condensers with the job of cleaning the proposed condensers. There are 325 return bends to be removed, scraped, and replaced with 650 gasket rings and 1300 nuts and bolts. Cleaning the two new condensers will require the removal of four heads and four gaskets, and only 160 nuts. However, air unit maintenance will be more time-consuming than was the case with the previous units. The new units involve more moving elements (more motors, pumps, and dampers) and more wetted surfaces (spray tanks and filter washing pans) which must be kept clean and free from corrosion if they are to remain dependable elements of a modern air conditioning system.

Follow-Up Check on Design Aids Operation

For nearly 50 years the history of air conditioning progress has been reflected, to a large measure, in the experience of the New York Stock Exchange. However, all of the Exchange's experiences have not been good ones.

It would be a gross understatement to call the troublesome features mere disappointments for, in reality, they have been the sources of considerable annoyance to the operating people and of great discomfort to the occupants. Looking back over the weak points, it is apparent that most of the difficulties could have been remedied soon after installation if a follow-up routine as a check on performance had been employed.

Since every system is, to some extent, a custom-made assembly, tailored to fit individual requirements, it becomes doubly important to test the extent to which the apparatus fulfills its design obligations.

In order to serve the best interests of the purchaser, a follow-up plan should include a complete survey of the functional operation of the system, and an analysis of the design and engineering. It should be made after the system has been in operation and the results should be incorporated into finished drawings. Not only would the adoption of such a follow-up policy reveal discrepancies between what the designer prescribed and what the purchaser actually received, but it would provide the operating man with information, not otherwise obtainable, that could assist him in a task that is far more complex than is generally believed.

Direct Fired Units Meet CHANGED HEATING NEEDS

Selective Operation of Warm Air Heaters Employed at Former Aircraft Plant Now Used as Warehouse

ADAPTABILITY of direct fired warm air heaters to extreme changes in heating requirements is demonstrated at the huge War Assets Administration sales center and warehouse No. 36, Cleveland. The property previously was occupied by the Fisher Cleveland Aircraft Div. of General Motors Corp.

During the war, thousands of employees were engaged in aircraft production at this plant. Today, only a few hundred persons are working there and use of the building has changed from manufacturing to large scale warehousing. The result is that the primary function of the heating system now is to establish and maintain approximately 60 F temperature throughout the sprawling structure as economically as possible. In addition, it is necessary to provide higher temperatures for short periods in certain areas where employees may be working temporarily.

Selective Operation of Heaters

Al Cousino, maintenance superintendent, and Frank M. King, assistant superintendent of the Duffy Construction Corp., contractors for the WAA, have worked out an ingenious method of meeting these heating requirements. They call it "selective operation" of the oil fired, warm air heaters, 79 of which were installed in the main building when it was erected during the early months of World War II. Today, by using between seven and 18 of them selectively, it is possible to achieve the desired results.

The main building at this facility is the "blackout" type—without windows—and is 1233 ft long by 1033 ft wide. It contains more than 2,500,000 sq ft and approximately 78,112,500 cu ft. In some places the ceiling height is 80 ft. Most of the floor space is uninterrupted.

In the basement, approximately 629,000 sq ft was excavated, including three corridors each 75 ft wide extending north to south, and four corridors 25 ft wide each extending east to west. Some areas in these corridors currently are used for storage. The corridors play an important part in the overall operation of the heating system because they act as ducts for recirculation of heated air.

Besides the corridors, approximately 400,000 sq ft of floor area in the basement is excavated. These areas are used for cafeterias, hospital, plant protection headquarters, fire department, display rooms, site sales office, an Army induction station, etc. All are heated by warm air from direct fired heaters operating with 100 per cent make-up air entering a plenum chamber and discharging into the areas through ducts. Temperature is maintained at 72 F in these areas.

All heaters are in the basement, either in special heater rooms or along the corridors. Warm air is discharged into the areas to be heated through ductwork, which in some cases extends to an open balcony (416,000 sq ft) in the main building. Along the east and west basement walls the heaters are double units, each having capacities ranging from 850,000 Btu to 1,500,000 Btu. Corridor units are mostly 750,000 Btu capacity. In all, there are 58 heater stations, 21 of them with double units.

On January 28 of this year, only seven heaters were being used to maintain 62 F in the main area, while the average outdoor temperature was 43 F. In contrast, on January 22 the outdoor low was 3 F and the high was 16 F. It then was necessary to utilize 18 heaters,

One of the oil fired warm air heaters located in the basement corridors. During the summer, cool air circulating through the corridors, which open to the outside at each end, is drawn into the filter chamber (left of the heater) and discharged into the main warehouse area which is 1233 ft long by 1033 ft wide with a ceiling height of 80 ft in some places

HH HH
B45 B45
PEARL HARBOR MIDWAY DRIVE

ARNOLD A. KOSARIN, of the Dravo Corp., describes the method of operating the direct fired warm air heater units at the big War Assets Administration sales center and warehouse in Cleveland, which was built and utilized as an aircraft production plant during the war. Primary function of the heating system now that the building's use has changed is to establish and maintain approximately 60 F temperature in wintertime as economically as possible, with higher temperatures where employees may be working temporarily

which were turned on at different times as the temperature dropped. Six others at various strategic locations were operated intermittently by the heating crew to meet fluctuations of the temperature. This, essentially, is the "selective operation" system.

Daily operation logs are kept to show which heaters are used and the hourly changes in outdoor and indoor temperatures. By studying these logs, Mr. Cousino and Mr. King have been able to determine which heating units can be used most effectively to maintain the 60 F temperature. At frequent intervals, only the blowers on some of the heaters are operated for mechanical recirculation of heated air returning to the basement corridors, through cold air ducts from the main area. Mr. King said he has found that if the corridor temperatures are kept at 60 F, the main floor temperature will be 60 F or more. When employees are working temporarily in a certain section, the heaters nearest the occupied area are operated to provide more warmth.

No. 3 fuel oil for the heaters is pumped at 40 lb pressure from outdoor storage tanks, having a total capacity of 96,000 gal. It enters the firing units at 1½ lb pressure.

An idea of the heating problem at this WAA warehouse—formerly an aircraft manufacturing plant—can be had from this picture. Versatility of the direct fired warm air heaters permits their use in heating this structure economically. By operating between seven and 18 heaters "selectively," maintenance engineers keep the working level temperature in the high ceilinged structure at 60 F

A survey was made recently to determine average consumption of fuel oil for all heating equipment, including the direct fired units, boilers for heating the administration building, and hot water heaters. Total amount of space heated was 84,070,700 cu ft.

Amount of Fuel Oil Used

During the month of February 1947—coldest February in Cleveland in 11 years—a total of 99,230 gal of fuel oil was consumed. There were 1186 degree days during the month, according to weather bureau reports at the Cleveland airport.

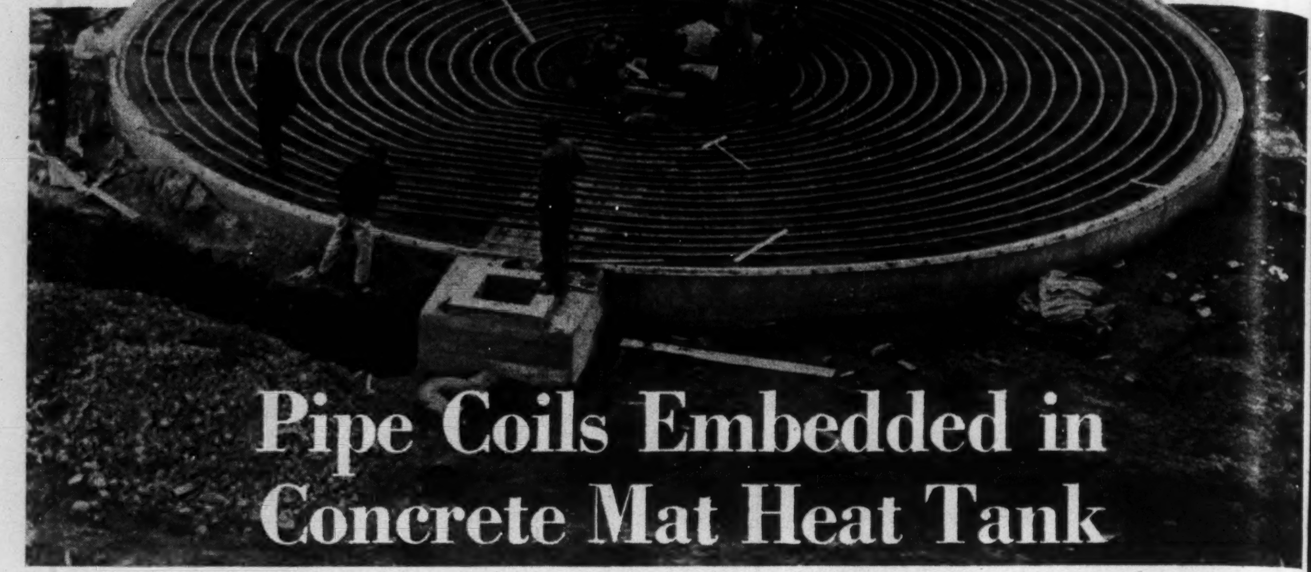
In February 1946 a total of 94,644 gal of fuel oil was consumed during 962 degree days, or an average rate of 98.3 gal per degree day. This compares with an average rate of 83.6 gal per degree day in February 1947.

An analysis of fuel oil consumption in relation to the amount of space heated revealed that during the period between February 21 to 28, 1947, inclusive, 68 per cent of the total fuel used was to heat 95.2 per cent of the total space heated. This space included the main building, in which direct fired heaters are used exclusively; the administration building, using boilers; and the administrative garage, using one direct fired heater. During this period, 15 heaters (six of them double units) were in operation at intermittent times to achieve a 60 F temperature constantly. The balance (32 per cent) of the fuel used during this period was for space heating in an adjacent hangar, a flight building and AAF garage, and for water heating.

Summer Air Circulation

Because the heaters warm up quickly and discharge at high velocity, the selective operation heating program devised by the maintenance staff at this facility achieves its purpose. The heaters also are important during the summer because they are used to circulate air in connection with the ventilating program.

Warehousing operations, as well as maintenance, at this WAA facility are managed by the Duffy Construction Corp., contractors for the WAA. Lyman A. Slack is general manager of this facility.



Pipe Coils Embedded in Concrete Mat Heat Tank

The two parallel pipe coils, each comprising 1000 ft of 2 in. steel pipe, after testing and before the concrete was poured

Hans J. Lang, of Day & Zimmermann, Inc., Engineers, Describes Process Heating Scheme for Big Thickener Tank Installed in Similar Manner to Radiant System

AN INTERESTING application of process heating was recently installed at a chemical plant in a thickener. This thickener consists of a rubber lined steel tank approximately 50 ft in diameter and 6 ft deep at the side. The bottom of the tank is conical with a slope of 1 in. per ft and rests directly on a concrete mat 6 in. thick.

The sides of the tank are insulated with 2 in. of magnesia and a weatherproof lagging. The thickener is covered with a wood roof and roofing paper approximately 2½ ft above the liquid surface. The roof was designed so as not to interfere with the walkway to the thickener drive at the center of the tank.

Under normal operation, the feed enters the center well of the thickener at about 125 F. The sludge and the effluent are discharged at a slightly lower temperature due to heat losses from the thickener. However, there are frequent periods during which other stages of the process are shut down and feed is not pumped to the thickener. During these periods it is important to maintain the thickener contents at 120 F by supplying sufficient heat to make up for the heat losses to the atmosphere and to the ground.

Several methods for heating the thickener were considered. These included steam coils, jackets, and pipe coils imbedded in the concrete mat in a manner similar to a floor type radiant heating system.

Steam coils could not be installed on the bottom of the thickener because of interference with the operation of the rakes. Steam coils at the sides of the tank would have produced convection currents which could not be tolerated due to extremely sensitive settling conditions. Furthermore, the acid nature of the thickener contents would have required expensive alloys for the coils.

Jacketing the sides of the tank for steam or hot water would also have proved unsatisfactory due to convection currents. In addition, jacket temperatures could not have exceeded 150 F for the type of lining (rubber) finally selected to prevent corrosion of the tank shell.

The type of heating system selected has the advantage of supplying a uniform flow of heat through the entire bottom of the thickener. The materials utilized for the coils were readily available. The design conditions were as follows:

Heat loss from tank, Btu per hr	200,000
Heat loss to ground from heating system, Btu per hr	90,000
Total heat to be supplied by system, Btu per hr	290,000
Area of bottom of thickener, sq ft	2,000
Total heat to be supplied by system, Btu per sq ft per hr	145
Temperature of thickener contents, F	120
Temperature of circulating water, F	190
Temperature drop of circulating water, F	10

Two parallel pipe coils were imbedded in the concrete mat. The coils are supported on 1½ in. angles. Each coil consists of 1000 ft of 2 in., schedule 80, steel pipe.

The circulating water is heated with steam in a shell and tube exchanger. A temperature controller in the steam line maintains the temperature of the circulating water leaving the exchanger at 190 F. Another temperature controller activates a three way valve in the circulating water return line to bypass water around the exchanger. The bulb for this controller is in the thickener.

The system has been in operation approximately one year. Performance has been satisfactory with a minimum of attendance and maintenance.

Radiant Heating, Apprenticeship Training Considered at Contractors' Annual Meeting

THE SUBJECT of radiant heating was given a good deal of attention at the recent meeting of the HPACCNA. Installation costs of panel systems, automatic control, the effect of panels on floor coverings, and the lack of uniformity in design procedure as set forth in various publications were some of the factors covered. The important subjects of labor relations and apprenticeship training also came in for much attention, with the new national apprenticeship standards being submitted to the members. The summary presented here completes our report of this important meeting

ONE OF the liveliest sessions at the recent Cincinnati convention of the Heating, Piping and Air Conditioning Contractors National Association (also reported on page 88 of the July HPAC) was the one in which the Why and How of Panel Heating was discussed by three experts who also answered questions from the floor. As was expected, great interest was shown by the members present.

Peter B. Gordon, of Wolff & Munier, Inc., launched the discussion by supplementing the published report of the radiant panel heating committee. John Haines, vice president, Minneapolis-Honeywell Regulator Co., spoke on temperature controls in radiant panel systems, and G. P. Nachman, of Spohn Heating and Ventilating Co., discussed his experiences from the contractor's viewpoint. All three answered questions from the floor.

Panels Not Harmful to Floor Coverings

Mentioning that at present there are eight major national manufacturers that have issued design manuals, that there are three new textbooks, numerous articles in technical and trade journals, etc., all devoted to radiant panel heating, Mr. Gordon said that a study of this mass of information disclosed extreme lack of coordination or agreement. He reported that his committee considers the standardization of design and application data to be the most important single problem. He mentioned the need for operating data and described a contest which will be put into effect in various engineering schools, whereby prizes will be awarded to senior mechanical engineering students for the best reports and analyses of operating and design data from actual installations.

Mr. Gordon also reported that the committee has been running down rumors to the effect that floor panels are harmful to floor coverings. Discussions with various manufacturers and trade associations concerning the general problem of the effect of floor panels on linoleum, rugs, cork, rubber, or asphalt tile floor coverings indicate that floor temperatures of 85 F will have no harmful effects. The alkali problem—moisture from the earth seeping up and dissolving alkaline salts in the concrete—was pointed out as being a problem of construction rather than a factor in radiant panel heating.

In regard to heat losses through the ground, for bare concrete floor panels on dry ground, Mr. Gordon used a figure of 11 to 15 per cent. Where linoleum is used on the concrete, this is increased about 2 per cent, necessitating somewhat higher water temperatures. Where rugs are used from baseboard to baseboard, he reported that the losses were considerably greater. At the close of the afternoon session R. G. Vanderweil, Chase Brass & Copper Co., said that assuming floor losses to be a percentage factor such as 11-15 per cent was risky because the heat was dissipated largely at the borders and for small buildings, the figures given might be inadequate.

Relative Lag or Mass Governs Temperature Control

In discussing temperature controls, Mr. Haines stressed the point that automatic control is important in any good system but especially so in radiant panel heating, where the air temperature and panel temperature must be selected simultaneously. The air temperature, he said, should not be lower than 63 F with maximum floor panel temperatures limited to 85 F. Any change in panel temperature affects the average room surface temperature more than it affects the air temperature. Sometimes a 5-7 deg reduction in air temperature is necessary under design conditions. Covering factors such as pick-up requirements, mass action, sluggishness and hunting of controls, and the importance of the ventilation rate, Mr. Haines said that the relative lag or mass between the panel and the structure is the most important single factor in the control of the system. He believes that, in general, it is impossible to adequately control systems where the mass or lag of the structure is small compared with that of the panel. Where the mass of both the structure and the panel is small, an inside thermostat will generally do the job. Where the structure mass is large and its lag great and where this construction is used with a panel having relatively little mass, he believes that an outside, anticipating type thermostat—usually supplemented by an inside thermostat—gives the best results.

Based on his experience, Mr. Nachman offered a number of recommendations to the members present. He said that the use of one coil of the serpentine type extending over large areas is poor policy. He prefers the use of one or more coils for each room with separate returns, balancing cocks, and arrangements for venting. He suggested that the cocks be located at a central point, such as in the utility room. Discussing a power breakdown, which might have caused freezing in a panel system if the cold weather and lack of power had continued, he recommended that systems be valved for proper drainage and circulation through all coils in the event of power failure in cold weather. Reporting on 18 installations, Mr. Nachman said that reports indicated good results but that in one installation, where baseboard-to-baseboard carpeting and padding were used, there was a lag in temperature control and some complaints had been received. In the other 17 jobs scatter rugs were used. He does not recommend the use of ceiling panels located above the ceiling plaster in an air space. In regard to structures similar to garages, he believes radiant panel systems to be competitive in cost to steam unit heater systems.

In concluding, he requested contractors to install some jobs in such a way that both 10 and 20 per cent of the coils could be valved off. This, he believes, will provide data necessary to settle the question as to whether present standards are suitable for radiant panel installations.

At the conclusion of Mr. Nachman's talk, questions were put to the three speakers from the floor. A contractor asked whether anti-freeze solutions were practical, and Mr. Nachman replied that solutions were used in snow melting systems, garages, and other intermittently operated jobs.

Says Panel Installation Costs are Competitive

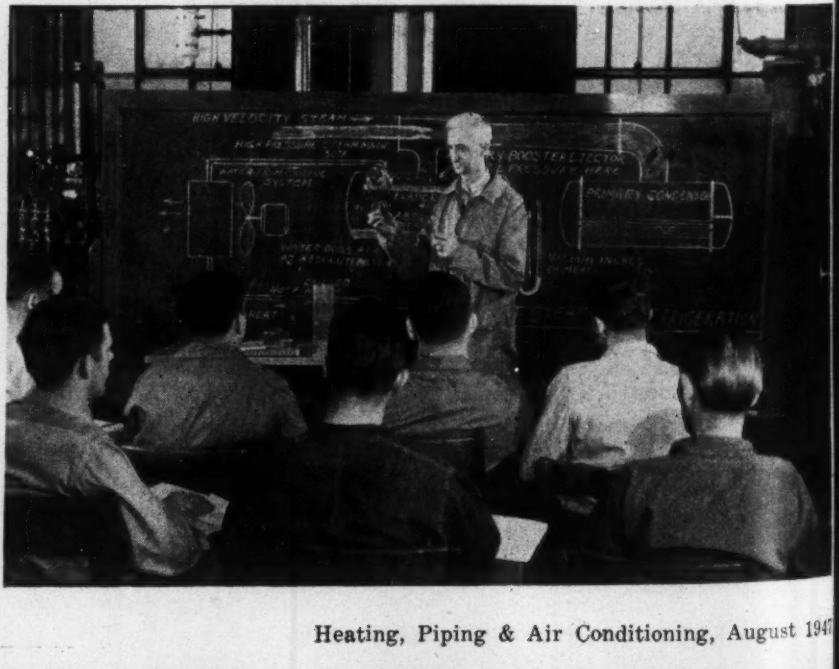
J. S. Kearney, of Northwestern Heating and Plumbing Co., requested clarification of Mr. Nachman's remarks concerning the relative costs of radiant panel and steam unit heater installations in garages, citing an instance where a 55,000 sq ft garage job was estimated to cost $1.00 per sq ft of floor area, with convectors being used in the offices, against an estimate which was about 50 per cent less for the use of steam unit heaters. In his reply Mr. Nachman said that while perhaps not equal in price, where there are showrooms or other direct radiation, the costs of the two systems should be within a reasonable distance of each other. Mr. Gordon also stated that he thought radiant panel systems could be installed in garages on a competitive basis.

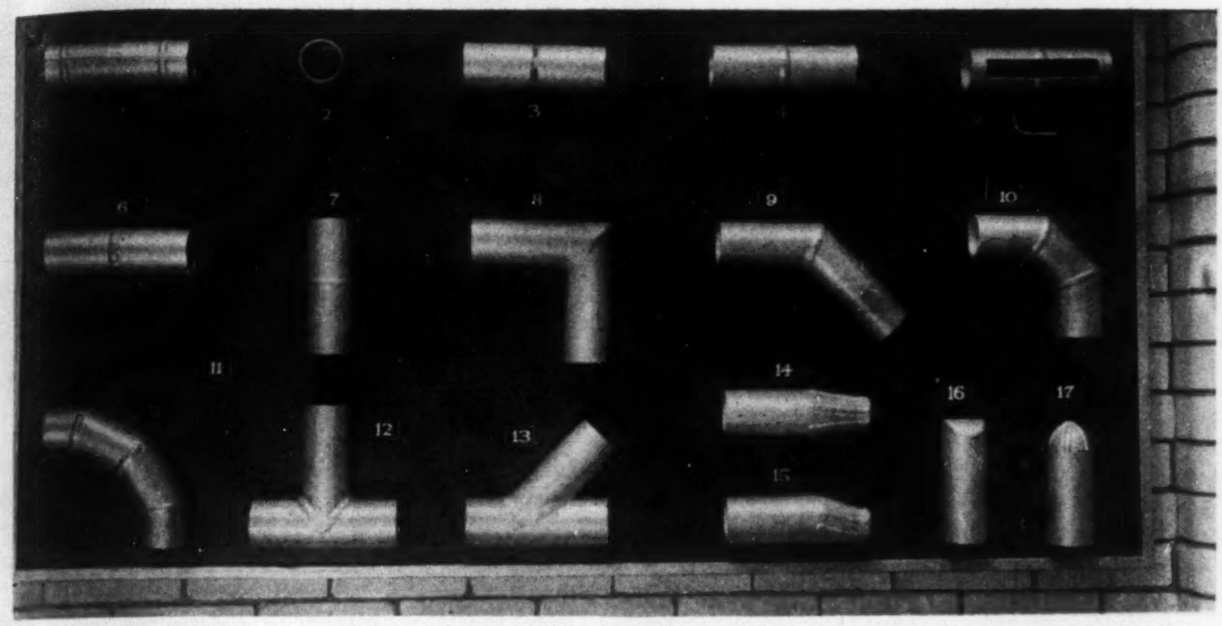
The question of controlling split systems where floor panels were used with a year 'round air conditioning system was brought up by a contractor. Mr. Haines said that the control problem was simplified in a split system as cool air would be available for reducing air temperatures where necessary to offset relatively high surface temperatures. A contractor mentioned a job now in progress in which each coil has been limited to serving 100 sq ft of floor area. In addition, the system has been arranged so that various section of coils can be cut out of the system. Mr. Gordon thought that was an excellent idea as it would provide much needed operating data. He asked if any other contractors were installing jobs in a similar manner.

J. H. McCauley, of James H. McCauley & Sons, citing the ventilation effects provided by unit heaters, asked if this wasn't an important factor in the choice of systems for garages. By way of reply, Mr. Nachman mentioned a radiant floor panel job installed in a garage and about which he was told (after some months of operation) that the warm floor apparently caused the exhaust fumes to rise so that they were not a problem. He said, however, that in time, various codes will probably require exhaust and ventilation in all garages whether heated by radiant panels or otherwise.

R. G. Vanderweil, who had been jotting down notes throughout the discussion, rose to make a few remarks and was asked to use the microphone. He stated that while there were differences in the published data and design procedures, most of the information now available is safe. He discouraged the idea

Classroom instruction is combined with laboratory and shop work at the Washburne Trade School, Chicago





Student welding operations included in the pipe fitting apprenticeship training program at the Washburne Trade School, Chicago, cover 1) beading, 2) beveling, 3) tacking, 4) rolling weld, 5) test coupon, 6) overhead weld, 7) vertical weld, 8) two piece 90 deg ell, 9) two piece 45 deg ell, 10) three piece 90 deg ell, 11) semi-welded turn, 12) tee, 13) lateral or Y, 14) concentric, 15) eccentric, 16) bull plug, and 17) orange peel

that air temperatures must be held within very close limits. In a study of 30 installations his company has found that a variation of 2-3 deg in air temperature is not too important. Of more importance, he said, is the psychological effect of a thermometer in the room. In mentioning the venting problem he recommended the use of an air eliminator at the boiler outlet. At that point, he said, the heated water has a tendency to discharge air which was previously dissolved at points in the system where lower temperatures prevail, such as in the heating coils. This is particularly true if water velocities are low at the discharge point. In regard to the necessity for the coil to be in contact with plaster, he reported that several tests indicate that a certain amount of heat will be provided if this is not the case, as where the coil is above the ceiling plaster in an air space. However, because many more tubes and hotter water would be required, he does not think such a method to be economical, as compared to plaster contact. He too thought that radiant panel jobs would be competitive with steam unit heater installations in garages, and he was greatly interested in the idea of arranging piping so that about 20 per cent of the effective coils could be valved off so as to provide additional operating data.

In answering a question about the applicability of boiler output ratings for radiant panel heating installations, Harry M. Hart, of L. H. Prentice Co., suggested that the boiler be sized against the building heat loss rather than for the installed coil surface as most contractors tend to provide more coil area than necessary in order to be on the safe side. He also suggested that a recording thermometer for water temperatures would provide the same information as valving off portions of coils. Mr. Gordon, however, did not agree with this as he thought this would introduce other variables and therefore heat output of panels at the lower temperatures would render the data less practical.

The association's committee on certification, of which Wray M. Scott is chairman, feels that the association should not certify radiant heating equipment until more data have been gathered. It was recommended that this committee continue to cooperate with the committee on standards and the committee on trade promotion and assist them in gathering the necessary information so that in the next two or three years a definite certification program can be formulated for radiant panel heating, using ferrous and nonferrous materials. It was also recommended that a definite certification program be worked out for baseboard radiation.

The importance of labor relations and apprenticeship training was given thoughtful consideration by the members in attendance. Martin P. Durkin, general president, United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada, discussed the modifications in the constitution of the United Association, designed to eliminate internal jurisdictional disputes by abolishing craft lines of demarcation within the association. As indicated by the new title of the organization, membership will eventually consist of journeymen and apprentices of the plumbing and pipe fitting industry. Mr. Durkin discussed the new national apprenticeship standards which are designed to qualify a trainee as a journeyman for work in the plumbing and pipe fitting industry after completion of a five year training program. He also described the constitutional change in the association which creates district councils designed to connect straight line local unions into a local organization so as to insure the abolition of trade lines of demarcation. These district councils will not alter the fundamental autonomy of local unions.

To eliminate strikes and lockouts in the industry, Mr. Durkin proposed the formation of a labor-management board of arbitration, to consist of an equal number of representatives from the HPACCNA, NAMP, and the UA.

The activities of the committee on apprenticeship were reported by Chairman Arnold H. Goelz who said that the national apprenticeship standards, submitted by the United Association, had been discussed in a joint meeting with representatives from other associations last September and as a result of the discussion, certain changes were made. Subsequently, recommended changes were submitted to the association's board of directors and to secretaries of local associations. The resulting comments and suggestions were included in revised standards which were submitted at this meeting for consideration and recommendations. To date, the principal recommendations concern the autonomy of local associations and it has been suggested that apprenticeship agreements be made between local associations of contractors and local unions. It was also suggested that the number of apprentices alloted to contractors and payments of wages paid to apprentices should be determined by local apprenticeship committees rather than be specified in the national standards.

Harry M. Hart rose to remark that in his opinion apprenticeship training is vital, as indicated by the average age of mechanics. He believes every contractor has an obligation and should employ at least one apprentice. A contractor asked how long an apprentice should be employed in one shop before moving on to another. Mr. Goelz answered by saying that, in his opinion, one year seemed about right.

Citing many industries which have courses in employee relations, J. S. Kearney suggested that the plan include a course designed to train future foremen. He said that it would be to the advantage of employers to cover the various relationships between management, owners, architects, and employees. Mr. Goelz agreed with this but hastened to point out that some men will always rise above others and that he thought such a course should be given only to the better men.

M. M. Hanson of the apprentice training service, U. S. Department of Labor, stated that much progress has been made, but with 60 per cent of the necessary local committees in operation, much remains to be done. At his request a show of hands indicated that most of the contractors present are now employing at least one apprentice. Stating that this is an association activity rather than a project for the individual contractor, he suggested the development, with the unions, of a local set of standards. Subsequent steps, he said, must include seeing to it that apprentices are indentured to the local committees, setting up a panel of candidates for apprenticeship and selecting them carefully, the determination of apprenticeship requirements on a local basis, and the publicizing of committee work. The expense of a training program must be shared by both the contractors and the unions, in his opinion.

Prices Must be Lowered

Supplementing the published report of the committee on trade promotion, of which he is chairman, George P. Nachman said that the industry is faced with the problem of bringing prices down—especially unit costs of field labor. Giving some figures on an overhead survey of 227 shops, Mr. Nachman stated that the answers to the questionnaire were obtained from contractors in 26 states. The annual volumes of business reported were: 5 shops, under $5 thousand; 27 shops, $25-75 thousand; 82 shops, $75-200 thousand; 59 shops, $200-500 thousand; and 51 shops, above $500 thousand. Three contractors did not report their volume of business. As reported, the total volume of business was approximately $101,493,000 with the average capital net worth of each firm being a little under $100 thousand. Based on material, labor, and other direct costs, the overhead was about 18.4 per cent. This substantiates previous studies. The data from the survey, projected for the entire association membership, indicate an annual volume of business of $½-¾ billion.

Interesting junior employees in management was discussed by F. E. Kise, vice president, Williamson Heater Co. Stating that young men are not "exposed" to responsibility in management, and that many times the business passes when management passes because the business has been virtually a one man affair, Mr. Kise described the experiences of his company in establishing "multiple management." He then used an organization chart to show how the idea of management by advisory boards could be applied to a typical contracting firm so that young men would share in the responsibilities and profits.

Steel Boiler Output Reaches All-Time High

More steel boilers are being produced than at any time in the history of the industry, shipments for the first 4 months of 1947 being 30 per cent above the corresponding period in 1941—in which year the industry reached its highest production. These are some of the significant facts about the steel boiler industry disclosed at the recent 19th annual meeting of the Steel Boiler Institute.

Members of the institute reported that production is being held back by lack of steel plate. The record output is being made possible by the continuous operation of plants unhampered by any serious labor disputes.

Difficulty in obtaining coal has created an unusual demand for oil burning equipment. It is expected that this demand will continue throughout the present year. Stocks of boilers in plants of manufacturers are negligible. It is expected, however, that the present delivery schedules can be maintained if steel mills continue to meet their deliveries on steel plate.

R. A. Locke was re-elected president of the institute, and Arthur P. Weiss, secretary, Burnham Boiler Corp., was elected vice president.

DATA SHEET

Simplified Procedure for SPECIFICATION WRITING

IN THE APRIL 1946 Heating, Piping & Air Conditioning there as an article entitled A Simplified rocedure for Specification Writ ng, by George W. Campbell. Due o several requests, it was decided o run as a supplement to this ar icle a series of specification cards hich are currently being used by he firm of Urdahl and Everetts, onsulting engineers, in their Vashington, D. C., and San Fran isco offices. Mr. Campbell is pres ntly employed in the Washington ffice.

The cards have been duplicated y the "Ditto" process. After the riginal duplication on 8½ x 11 in. aper, the copies were cut into 5 x 8 n. cards. The "master" ("Ditto" erminology) was also cut out and led in a 5 x 8 card file. The origi al cards have no dates. As the ards were revised, a date was dded so that an obsolete card ould not be used.

The cards are in two sections, a ttered series and a numbered eries.

Let us assume a specific problem. e have designed a direct fired air nditioning system. We would go the files and remove card No. A. ooking under paragraph 1, we ote general intentions, scope of ork, and time of bids. These items hould be written on a 5 x 8 in. card or paper and should be given the numbers noted.

Consulting engineers and architects usually have a permanent set of conditions which they use for the particular locality in which they work covering such items as checking, definitions, delays and extensions, and accompanying drawings. These are included in paragraphs 2-31 indicated as printed matter; if we do not want to use 30 paragraphs for this material we can easily change the number.

Paragraph 32, work to be done by others, is another paragraph that will have to be written out for each job as every job will be different.

We now have arrived at the part of the system that is a time-saver. We go through the file and pick out all cards having numbers which are listed on Card No. A, following the title of the specification as direct fired air conditioning unit (1), heat exchanger (9), oil burner (11), etc. In our particular problem we won't need some of the cards. Let's assume we are not responsible for the domestic hot water system, which in this case is a plumbing job; therefore, we return card No. 39 (domestic water heater). Again, let us say the architect is to include in his specification all flashing where it is needed; therefore, we return card No. 34 (flashing).

We now take the cards and number them. Paragraph 33 of our specification will be given to direct fired air conditioning unit (Card No. 1), paragraph 34 to fuel oil tank (Card No. 23), etc. Should any of the cards now become separated, that loss will be easily detected when the secretary starts to type them.

After all the cards have been properly marked for the conditions of the particular job, we turn them over to the typist. After typing, the cards can be stapled together and placed in the job file.

The principal advantage of the system is that the engineer is saved time by not having to write out each specification every time it is desired to specify that item, and it eliminates errors which result from trying to transpose longhand. An added advantage is that an individual specification can be changed by substituting the newly written specification using the old number in place of the obsolete cards.

Several of the cards have been published in the June and July issues, more appear this month, and others will follow. Because of space limitations, they are shown smaller than the 5 x 8 in. size. These specifications are not to be construed as recommendations to other consultants but to illustrate this card file used by Urdahl and Everetts.

Card No. 10
Job. No. ___

___ BOILER: The heating boiler shall be automatic gas fired automatic oil fired stoker fired hand fired. coal for hot water steam, having an output of __________ Btuh. This boiler shall be complete with standard trimmings as listed in the current manufacturers catalog and shall in all respects be similar and equal to the ________ model, ______ size as manufactured by the ______________________________. This boiler shall comply with all the requirements of the District of Columbia Boiler Code, Washington Gas Light Company, ASME Boiler Code. ______________________________.

Card No. 11
Job No. ___

___ OIL BURNER: The oil burner shall be an integral part of the unit capable of efficiently burning not lighter than No. __ fuel oil at a rate which may be varied from ____ gpm to of ____ gpm. The burner shall be equipped with a positive gas-electric spark ignition for fully automatic control and shall have all the required safety controls to meet the specifications of the National Board of Fire Underwriters. It They shall be of the gun horizontal rotary vertical rotary type burner, and the motor shall be wound for ___ volts, 60 cycle, three _____ phase current.

Card No. 12
Job No. ___

___ STOKER: A stoker of the underfeed worm ram type with variable ___ ____ steps of coal feed with a maximum capacity of ______ pounds of coal per hour shall be installed under the boiler in accordance with the manufacturer's direction by skilled mechanics. The stoker shall be a standard product of the manufacturer and shall be designed for the efficient combustion of low volatile slack coal No. ___ Coal. The stoker shall be completely automatic and shall be provided with a device for automatically maintaining a constant static pressure over the fire.

The hopper shall have a minimum capacity of ______ pounds of coal, and the retort shall be of the sectional type with an active combustion area of not less than ________ square feet.

The electric controls shall be similar and equal to those manufactured by the ______________________________ and shall consist of the following:

a. A low water cut-off to stop the operation of the stoker if the water-level in the boiler drops below the predetermined level.

b. A pressure control with a high and low differential setting up to ______ psig.

The stoker shall be operated by a _____ hp motor wound to operate on ___ volts, 60 cycle, ____ phase current of the totally enclosed type operating at a maximum speed of ___ rpm with a maximum temperature rise of 40 C.

The stoker shall be similar and equal to those manufactured by the ______________________________

Card No. 13
Job No. ___

___ COMPRESSORS: The Contractor shall furnish and install where shown on the plans _____ Compressors Condensing Units designed to have the capacity of ___________ Btuh each with a saturated refrigerant temperature of ___ F. at a head pressure not to exceed ____ psig at a maximum speed of ___ rpm for belt driven compressors or ___ rpm for direct driven compressors, using Freon 12 __________ as the refrigerant. The units shall be complete with suction line strainers, cut-off valves, and high and low pressure safety cut-off switch, and shall have approximately _________ 50% capacity reduction by the ______________________________ cylinder bypass cutoff method.

The compressors shall be equal in size, model, and manufacture, and shall be connected in parallel with an oil equalizing system as recommended by the compressor manufacturer. A detail of this piping shall be submitted for approval.

The compressors shall have an electrical switch in the control circuit which will automatically cut off the refrigeration system in case of an inadequate supply of oil.

The compressor motors shall be wound for ___ volt, 60 cycle, _____ phase current.

The compressors shall have a reinforced concrete ______________ base of the approximate size and dimensions as shown on the plans and as required by the particular compressors.

Card No. 14
Job No. ____

____ WATER COOLED CONDENSERS: The condensers shall be mounted as an integral part of the compressors to form a condensing unit by the manufacturer of the compressors, complete with water valve regulated by head pressure, and shall be designed for operating with that those compressors.

The condensers shall be of the shell and tube coil type with removable heads to facilitate cleaning and shall have copper ________________ tubes. It They shall be designed for use with "Freon 12" ________ refrigerant and shall have the volume to hold __________ the entire charge of refrigerant. They shall have the capacity to handle the heat load from the compressor as specified, using not in excess of ____ gpm with a maximum water pressure drop through the condenser and water valve of ____ psig with the water entering the condenser at ____ F.

Card No. 15
Job No. ___

___ EVAPORATIVE CONDENSERS: The Contractor shall furnish and install where shown on the plans ____ evaporative condensing units designed to have the capacity of ______ Btuh each with a wet bulb temperature of ___ F and a head pressure of ___ psig, using "Freon 12" __________ as the refrigerant. The evaporative condensing units shall be complete with a fans, motors, water pumps, sub-cooling coils, liquid receivers, and make-up water valves. The liquid receivers shall have the capacity to hold _____________ the entire charge of the refrigerant. The fan shall be designed to deliver approximately ______ cfm against an external static pressure of ___" water pressure at a maximum speed of ___ rpm. The fan motor shall be ____ hp. The pump shall handle ____ gpm against a head of ___ ft of water and shall have an indirect connected motor of ____ hp with a synchronous speed of ____ rpm. The support for the evaporative condensers shall be as shown on the plans. This equipment shall be mounted on a base in a manner as shown on the plans.

Coils shall be prime surface (plain tube) copper tube, hot dipped galvanized, steel _________________________.

Card No. 16
Job No. ___

___ FANS: The fan is to deliver ______ cfm against an external static resistance not including filters of ___" water pressure with a ___ hp motor at a maximum fan speed of ____ rpm according to the American Society of Heating and Ventilating Engineers Code.

Card No. 17
Job No. ___

___ EXHAUST FAN: Furnish and install _____ radial axial flow exhaust fans where shown on the plans. Each The fan shall be capable of delivering _____ cfm maximum to the outside against an external static resistance of ____" of water pressure. The fan shall be belt driven directly connected, and the motor shall be ___ hp, wound for ___ volts, 60 cycle, ____ phase current to operate at the one two speeds of ____ rpm and ____ rpm. The fans shall be reversible.

Steam for Air Conditioning Discussed by NDHA

John F. Collins, Jr., Secretary-Treasurer of the Association, Also Reports on Industry Problems of Lowering Costs, Securing Adequate Rates

INCREASED USE of district steam for summer air conditioning as a means of building up load factors was proposed by Boris Dmitrieff, construction engineer, Consolidated Edison Co., New York, during the recent 38th annual meeting of the National District Heating Association, held at Atlantic City. In his paper, one of many which received thoughtful consideration by the members present, he pointed out that the load factors for the 12 largest district steam companies now average less than 30 per cent. After mentioning that this desirable load would require little or no additional capital investment by the steam companies, he described various types of air conditioning equipment now available for use with purchased steam.

Mr. Dmitrieff predicted further developments and uses of absorption units with new refrigerant-solvent combinations. In his opinion the use of steam jet machines has been limited because of the lack of aggressive promotion and the fact that the equipment was placed on the market before it was fully developed, particularly with respect to controls. Introduction of capacity control, he said, has resulted in reducing seasonal steam consumption of some installations by as much as 35 per cent. He believes this type of unit can be utilized economically for installations of 200 tons or more, where steam is available at 100 psi or more, where the cost of water is low or where space is available for a cooling tower, and where the sensible heat load factor is high.

Recognizing that the uses for the steam engine in air conditioning are limited, he pointed out that the present trend in larger installations (250 tons and over) is toward the centrifugal compressor. He described the steam turbine as ideal for this application, stating that the advantages include reliability, compactness, economy of operation, and low maintenance cost.

Steam Costs Up

NDHA President John F. Malone, assistant manager, district steam dept., Consolidated Gas Electric Light and Power Co. of Baltimore, in his annual address dwelt on increasing costs in district heating. He said that the cost of erecting new generating capacity had increased 100 per cent since 1940 and is now about $8 per pound of steam capacity per hour. With a 25 per cent load factor on a sendout basis and with the usual 20 per cent required reserve capacity, the fixed charges at the rate of 15 per cent on the new generating plant would amount to 77 cents per M lb of steam sold when the capacity was fully loaded except for reserve.

Furthermore, he said the cost of generating steam also has increased in some places 50 per cent, at others as much as 90 per cent, resulting in a production expense ranging from 67 cents to 77 cents per M lb sold in the larger companies. These costs of capacity and production added together give a total steam cost of approximately $1.50 per M lb sold.

On the other hand, he pointed out, rate increases have not kept pace. The highest rate reported to the operating statistics committee of the association was $1.30 per M lb sold.

The operating companies, President Malone concluded, must not only consider the possibilities of increasing rates and offering tariffs that will serve the producer and the consumer best, but they must reanalyze all operations and study the new relationship of fuel, labor and capital.

At the president's call, the author made his eighth annual report. The report said the association was in good financial condition but was feeling the effect of higher prices and having printing difficulties. It said that during 1946 the properties of more than half the utility members had been visited and that a considerable percentage of the time of the headquarters staff had been consumed in answering the questions of members and others.

Membership Chairman Leonard S. Phillips of the New York Steam Corp. reported that the reclassification of members under the new constitution had been completed and there was a satisfactory increase in membership.

The advisory committee, whose function it is to study and advise the executive board of changes it would propose, through its chairman, E. E. Dubry of The Detroit Edison Co., this year recommended that the association hold more than one session at a time during annual meetings so as to permit more time for the most interested parties to discuss important problems.

Weather Affects Sales

The operating statistics committee gave some interesting data on the business of 60 heating utilities reporting annually. Committee Chairman E. T. Smith, of The Detroit Edison Co., reported that 90 per cent of the companies experienced warmer weather in 1946, there being a decrease of 10.05 per cent in the number of degree-days on a company average basis. Therefore, as might be expected, 75 per cent of the companies had decreased sales, and as a further result, total revenue decreased 3.57 per cent. On the other hand, there was an increase in average revenue of 3.4 per cent with 95 per cent of the utilities reporting higher figures. There was a normal increase in connected load. The capital investment of the companies increased approximately 3.5 per cent during the year. The increase in fuel cost in cents per million Btu was double that of 1945.

Lines on Private Property

The commercial relations committee, under the leadership of its chairman, Alfred T. Veness of Rochester, N. Y., presented two papers that elicited much discussion.

The first of these by Mr. Veness concerned the securing of rights-of-way for steam line extensions on private property. In it the author summarized the answers of 15 steam utilities to 8 questions regarding (1) the percentage of steam systems on private property, (2) the routine of securing agreements, (3) the types of these agreements, (4) the advantages, and (5) the protection and compensation given the property owners.

NDHA Executive Board and Committee Chairmen

Seated, left to right: D. W. Loucks, Walter Wisschusen, J. A. Barnard, J. J. Collins, E. T. Smith, G. H. Tuttle, R. D. Martin, J. F. Collins, Jr., W. A. Schulmeister, H. L. Martin, C. W. Deeg, A. R. Mumford; standing, left to right: P. A. Hyde, M. A. Hanna, J. E. Seiter, T. P. Brown, Jr., L. S. Phillips, A. F. Metzger; absent: J. F. Malone, A. T. Veness, J. T. Davis, and H. A. Weitzman

The various utilities reported from 1 to 15 per cent of their lines on private property. Most had less than 5 per cent. Two companies reported they obtained permanent easements for their lines. The others normally secure permission to have their lines on private property for periods of from 3 to 5 years with automatic renewal clauses from year to year thereafter. About half of the companies have standard forms of agreement. The others consider each case separately and make agreements as needed.

The securing of a right-of-way often makes it possible for a utility to serve customers which otherwise it could not connect because of the distribution line cost involved. Maintenance costs are likewise lowered. Property owners benefit by having service available and sometimes by lowered connection costs. Only in rare cases is any money paid to the property owner. The agreements customarily include clauses protecting property owners from liability for any damage or injury.

The second commercial relations paper was by O. J. Prentice of the C. A. Dunham Co. Mr. Prentice described the various types of control equipment designed to produce conditions of comfort with greatly varying outside temperatures.

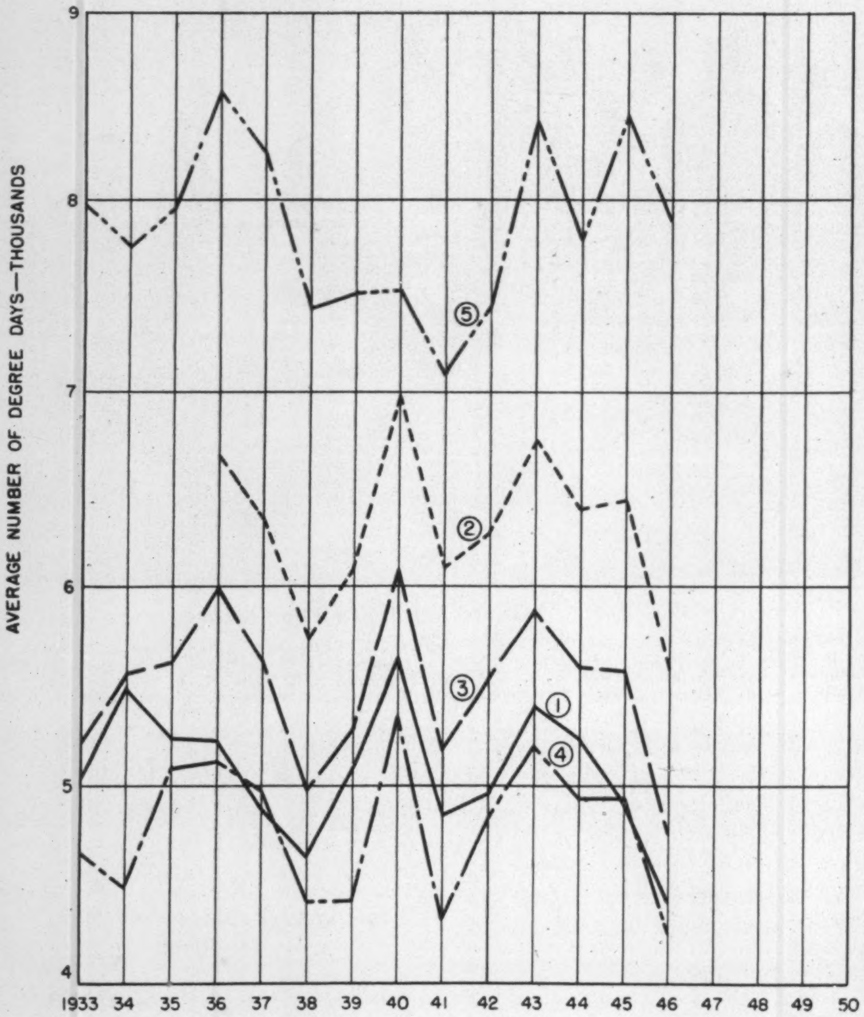
Discussion of this paper centered on the effect of controls and night shut-off on peak demands (on the utility generating equipment) during the morning warm-up periods.

Reports Progress on New Handbook

J. Earl Seiter of the Consolidated Gas Electric Light and Power Co. of Baltimore, chairman of the educational committee, reported that many members of the association had been cooperating with his committee on the production of the third edition of the District Heating Handbook, which was the principal project of the committee during the year. He said that some of the chapter manuscripts had already been delivered to headquarters by the authors and all others are now being prepared. He said all copies of the second edition have been sold and he estimated it would be a year before the new edition is ready.

In his report, the insurance committee chairman, James E. Harris of the Philadelphia Electric Co.,

IMPROVING LOAD FACTORS through the use of purchased steam for summer air conditioning, rising steam costs, securing rights-of-way, the effects of variations in weather on steam sales, temperature control equipment, and rate increases were among the subjects discussed at the 38th annual meeting of the National District Heating Association at Atlantic City. Other topics of the meeting will be reported in a second installment



Annual degree days as reported by member companies have decreased since 1943

The reports are divided into five groups based on annual steam sales as follows: (1) over 10 million Mlb, (2) 2 to 10 million Mlb, (3) 1 to 2 million Mlb, (4) ½ to 1 million Mlb, and (5) 275,000 to 500,000 Mlb, (Mlb = 1000 lb)

warned the utility members to watch closely insurable values of buildings, machinery, equipment, fixtures, betterments and improvements in this rising market. Safe and adequate insurance, he said, should be carried to reimburse for probable losses.

He said it is fundamentally sound never to depreciate property below its utility value. One has a perfect right to insure property for its true value.

Mr. Harris concluded with a warning of the staggering annual losses of life and property by fire amounting in the United States to 10,000 lives and half a billion dollars annually.

C. L. Follmer of the Baltimore Company gave the rates and regulations committee report due to the absence of Chairman H. A. Weitzman, manager of the rate and economic research dept., Rochester Gas and Electric Corp., Rochester, N. Y.

Statistics gathered and compiled by Mr. Weitzman showed that eight companies increased rates in 1946 in amounts from 8 to 25 per cent. Thirty utilities reported no rate changes in the period. However, all indications were that there will be many rate changes upward in 1947.

Four companies added or revised fuel cost adjustment clauses in their rates in 1946. For many utilities these clauses to a great extent offset increased coal costs during the year.

Apportioning expenses not directly allocable, such as those for accounting, collecting, sales promotion, and general administration in companies selling gas or electricity as well as steam was the subject of a paper by E. J. Steinberg, Wisconsin Electric Power Co., Milwaukee, Wis. Mr. Steinberg showed that there can be no uniformity in accounting because of variation in company operations and conditions.

Court and commission decisions since 1940 on steam matters were summarized by M. A. Barbour of The Detroit Edison Co. His paper showed that in nine decisions utilities were permitted to raise or lower their rates to bring returns of between 5 and 6¾ per cent. Four of the actions were in Pennsylvania, where the public utilities commission allowed 6¾ per cent as reasonable considering the special competitive risks involved in the business. Four companies were authorized to abandon service.

Chairman Weitzman reported on the draft of the chapter on steam rates completed by him for inclusion in the new edition of the District Heating Handbook. It contains such subjects as rate fundamentals, depreciation, cost analysis, rate designing, glossary of terms, types of rates with examples, special rate provisions or riders, open jet rates, rate schedule makeup and contents, and rate comparisons.

He said that rate making attempts to blend in rate structure forms the various requirements of the sales and operating departments to help promote proper load growth consistent with economically justified plant capacities and the most economical operation of the system, and at the same time to meet the competition of other fuel, so as to promote greater and better use of steam service. In the economist's language, rate-making is "a problem of pricing a service."

Association Considers Research

After a year's study by the chairmen of the advisory and research committees, respectively E. E. Dubry of The Detroit Edison Co. and A. R. Mumford of the Combustion Engineering Co., Inc., they recommended that financed research such as is carried on by other heating organizations should be undertaken by the association for district heating. They further reported that the phases of the business likely to yield the biggest return per dollar spent on research are (1) plant operation, (2) distribution system design and construction, and (3) plant design and construction.

SAM LEWIS' PAGE

In this regular feature, informal comment on heating, piping and air conditioning matters is given by Samuel R. Lewis, consulting mechanical engineer and member of HPAC's board of consulting and contributing editors. This month he describes some of the troubles he's had with air intakes and outlets installed in building courts, and he casts his vote against the indiscriminate use of goosenecks

Intakes, Outlets in Courtways Can Lead to Plenty of "Grief"

I SEEM TO STIR up some independent thinkers who are vocal about it. Concerning chimney tops—about which I wrote in April, and on which I have had several comments from readers of that page—I have not made any recent researches with instruments. Of course, if the wind movement is upward around the top of a chimney, the well known ejector encouragement of draft will be manifest. Given a chimney top of such character that an ejector-like condition results from horizontal wind action, the chimney draft will be improved. I submit that a plain round steel chimney top can be improved upon as a gas ejector in a wind storm. My principal idea in writing about chimney tops was to attack the gooseneck.

Inlet and Outlet in Deep Court

A very recent experience bears out the wisdom of this attack. An otherwise competent engineer did arrange a gooseneck outlet and a gooseneck inlet in the same deep four sided court, about 15 x 20 ft in plan, in a tall building. The court floor is 10 stories down from the roof of the main building. An outlet from an exhaust fan that discharges odorous warm air was placed close to the court floor. An inlet for outside air was placed about 20 ft above the court floor but within the same court.

The designer was a "gooseneck addict." A fundamental error was in placing the outlet at the floor and the intake at a higher level, but even had this not been done there are wind and barometric pressure conditions that could have caused trouble. The gooseneck was invented and used by the goose for intake purposes. Maybe a goose vomits, but I never caught him at it. Fig. 1 shows the court condition as I found it. Several thousand dollars was supposed to be saved by not extending the outlet duct all the 10-story way up above the main building. If the higher opening had been the discharge outlet and if it had looked up so that the warm

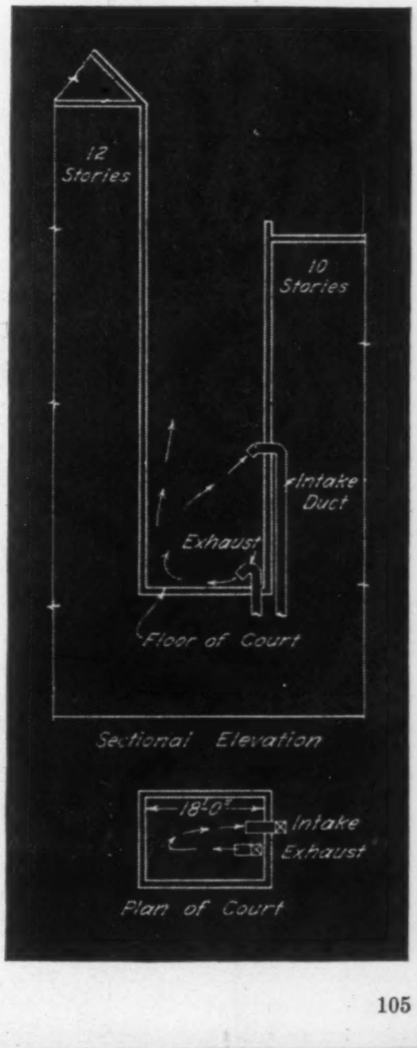


Fig. 1—Several thousand dollars was supposed to be saved by not extending the outlet duct to a level above the roof, but it may be necessary to do this to overcome the wind and barometric conditions that are causing trouble

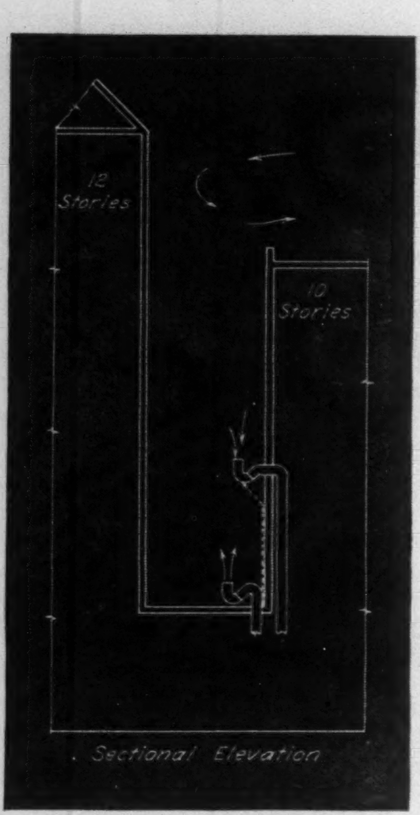


Fig. 2—The first attempt to correct the installation shown in Fig. 1 is to change the goosenecks, as shown here

air could get away, the dilution might have been sufficient not to be objectionable at an intake close to the floor of the court. It may be that the supposed saving will have to be abrogated; and that one or the other of these ducts must be extended above the highest point of the roof of the building at the left side of the court in Figs. 1 & 2.

The first answer to be tried out in this case is to change the goosenecks as shown in Fig. 2. Possibly, the air from the outlet will be sufficiently diffused by the time it passes the up-looking intake that odors and heat will not be noticeable. If this scheme fails, then one of the ducts, preferably the outlet duct, should be extended all the way up.

Contaminated Air Supply for Hotel

Another case having to do with contaminated air supply is a new plant in a hotel. The intake is in the south wall above the roof of a garage and close to the garage roof, at third story level, as shown in Fig. 3. The court is open to the street on the west but otherwise has tall buildings on three sides. The garage paint shop is 50 ft from the intake. When the wind is from the west, air enters the paint shop windows, emerges through the door into the court, crosses to the intake of the hotel, and causes vociferous complaints. The answer probably is to extend the intake to the roof or to run it horizontally west above the garage clear to the street. The hotel has spent all its money and hates to incur this investment. This is a case where health department code compliance has been certified.

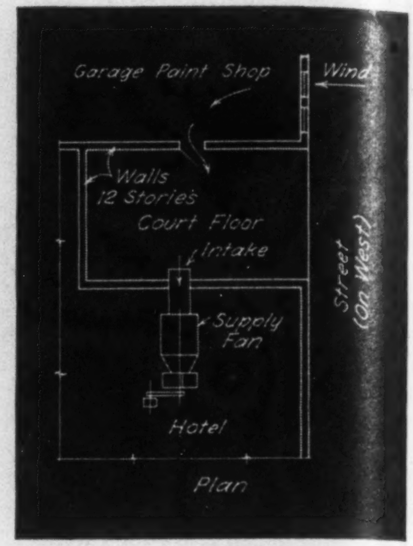


Fig. 3—The answer to correcting the troubles on this job is probably to extend the intake to the roof or to run it horizontally west above the garage clear to the street

No code can cover every peculiarity in design or construction or can protect an owner against all of the operations of the neighbors. This situation, however, is recorded by me for my own education and I hope that it will have a salutary influence on the engineer who designed the too-expedient inlet location.

For myself, I'll continue to try to find intake openings high above ground and high above roofs, in side walls, preferably on the north and preferably *not* in courts where barometric pressure can pocket the off-scourings.

Gets Permission to Restrict Conditioning

Following a public hearing earlier this year, the Missouri Public Service Commission granted permission to the Kansas City Power & Light Co. to restrict the use of electricity for air conditioning this summer. Every effort is being made to avoid *any* restrictions. However, increased use of electricity since the war, coupled with delays in the delivery of new generating equipment which was ordered in 1941 for installation in 1943, may make some curtailment necessary, according to the utility. If restrictions are invoked, approximately 420 of the larger air conditioning installations will be affected. To secure a comparable reduction in power load, 40,000 to 50,000 residential customers would have to do without electric service during the summer peak periods.

Restrictions will be applied only in the event of an emergency occasioned by the failure of a large boiler; the failure of a turbine; or prolonged periods of hot weather and the resulting increased demands for electricity.

Should the use of air conditioning be curtailed, the restrictions will apply for a maximum period of five hours daily, Monday through Friday. Customers are to be advised by telephone the day before that, until further notice, it will be necessary to curtail their usage of air conditioning equipment from 9:30 to 11:30 a. m. and from 1:30 to 4:30 p. m. The restrictions do not apply to installations totaling less than 10 hp; hospitals, or in cases of illness where the restrictions would result in a hardship to the patient; or refrigeration customers, where the preservation or processing of food is involved.

QUESTION OF THE MONTH

Readers Answer Question on Theater Return Air Intakes

In a question published in the July HPAC, "T.L." asks about return air intake location in a theater that is about 188 ft long and 50 ft wide. The floor slopes from the rear toward the stage, with a level ceiling. The clear height at the stage is 25 ft, and at the opposite end the clear height is 8 ft. This is evidently rather a steeply sloping floor.

The architect proposes to introduce air that will be warmed in winter and refrigerated in summer through several grilles along the side walls, and to remove the air for recirculation at the floor level at the stage or deep end only.

"T.L." indicates there is no provision for exhausting any air outdoors or for replacing it with new air from outdoors. He gives no information as to the volume of air to be handled or the design temperature of the air when cooling or when heating. I do not know enough about the project to criticize or endorse any part of it except the suggested locations for intake and outlet. I do feel able to lay down (for reaction by ever-critical readers) a few precepts, as follows:

Some Points to Consider

1) The air delivery volume should be not less than 2 cfm per sq ft of audience-occupied room. This includes aisles, columns, and other nonpaying areas inside the walls of the room. Less volume than this will require that the entering air shall be so much cooler than the air in the room at the level of the inlets, that complaint of drafts will be made.

2) Air delivery well overhead, along the side walls through several grilles (say one every 15 ft) generally is not objectionable, and such delivery from high-up grilles at the stage end so that the air currents face the audience, is usually acceptable. Air delivery through the ceiling in such a room has been found usually free from trouble.

3) Removal of the air from such a picture theater as is described, limited to grilles at the floor only, at the deep end, generally is unacceptable. The only exception is in very cold weather if there is no carrier of the heat except the air, in which case, unless there is means for the relatively heavy cold air to escape at the deep end, the floor down there may be cool. It has been well proved by experience that when we attempt to cool a room in hot weather, and have recirculating or exhaust openings only at the floor, we can be very sure of trouble.

YOU ARE invited to submit a heating, piping, or air conditioning question for publication. You are also invited to submit answers to questions from others, which are paid for at regular rates

The relatively heavy cool air, entering the room at, say, 60 deg into a zone where the room air may be at 80 deg, or even warmer. tends to fall toward the bottom of the room and if there is an escape opening there, as for recirculation, the cool air will slide happily out, leaving the lighter-weight hot air in the room to rise toward the ceiling and become hotter—to discredit the designer. If, when cooling such a room as that described, the return air or exhaust air openings are overhead, the hottest air will skim off like dross in a lead melting pot, and the cool entering air will settle gracefully and gratefully around the people.

If—in such a theater as that described—there are a few radiators down in the low zone, there will be no trouble if the year-around return air outlets are high overhead. It is not usually too difficult to arrange for seasonal or even for hourly switching of the air removal level from low-down to high-up.

If the room gets too warm, just open the overhead vents.

Use Outdoor Air

4) I know no area in the United States in which at some considerable time during each year, the untreated outside air is not delightful to feel and breathe. I know of no audience room in the United States in which this outside air—moved in copious quantities, and neither heated nor refrigerated—is not desirable in order to control temperature and odor. Any designer of a theater should be excommunicated if he fails to provide ventilating equipment capable of introducing and removing 100 per cent of this outside air when no heating or cooling is needed. He should be shot at daybreak if he fails to teach the operator to introduce and remove enough outside air to dilute the characteristic and not always pleasant odor of too-warm humans.

5) In North Dakota we are called upon to redesign the ventilating of a very large and otherwise attractive assembly room because of failure by the designer to provide any openings (to say nothing of fans) for removal of spent, hot, smelly air. No appreciable volume of new air can enter unless there is a vent for escape of the original, old, wornout air. In Pennsylvania we are compelled to reverse the unfortunate original design of a theater ventilating system (and we should like to do so in many local theaters) where the entering air

emerges through openings in the floor under "mushrooms" and escapes through the ceiling. The entering air currents in these cases are too intimately located with reference to the ankles of the audience.

In California we are correcting an exceedingly flagrant case of air introduction for cooling a theater where the air supply was delivered into the room through grilles behind the audience. The ticket purchasers for years have emerged as nervous wrecks following fear of a cold due to the impact of the cooling air on areas of their bodies, from directions that their bodies are not trained to accept.

Incorrect Equipment Location

In Chicago we are spending a lot of dollars to correct a case in which the designer filled with machinery the basement under an otherwise attractive and useful place of assembly. There are nine fans and electric motors, 12 pumps of various kinds, and hundreds of feet of hot pipes under this room, with only a thin concrete floor as a barrier. Each machine tells the audience of its coming on and going off and the audience suffers from the hot-foot disease due to the very warm floor.

That reminds me of another large theater that for years endured under its floor an extensive electric substation full of switches, motor-generator sets and the like. I helped abolish that one—S.R.L.

The question from "T.L." in the July issue on return air intake location in a theater interests me for two reasons: the first is because of what might be termed the ethics of the situation, and the second is the technical problem involved.

Question of Ethics

Regardless of the problem involved, I agree heartily with "T.L." in that he has refused to prepare a design on a basis dictated by others, when he believes such a design is faulty. Consultants daily are confronted with this same problem, usually forced on them by the desire of architects to avoid changing their designs, failure of architects to understand the art of air distribution, failure to provide sufficient space for equipment, and because of the client's natural desire to cut costs.

I do not mean that the architect should be required to change his basic design at the whim of the mechanical consultant. Usually, a little cooperation is all that is required. One of my most pleasant associations is with a well known firm of architects, which calls me in during the preliminary stages of a project. By both of us realizing the problems of the other, we have been able to serve the ultimate client to far better advantage than if one of us had been dogmatic in refusing to see the requirements of the other.

I appreciate the normal desire of the client and the architect to keep the cost of mechanical equipment as low as possible. However, it is not appropriate to construct a fine building, regardless of cost, and then limit the mechanical equipment to a point that it performs its function maybe 50 per cent of the time. It is easy to design an air conditioning system that will perform at guarantee under maximum design conditions. However, it is another story to make that same system do the work under intermediate conditions. The architect should properly leave this to his consultant, or if he does not have proper confidence in the consultant, he should get another one.

Object to Air Currents on Back

In regard to the problem of "T. L.", based on the size of the theater, it appears to have capacity of about 1200 seats. In other words, this does not appear to be a "neighborhood theater," but possibly a first run house. If so, I believe a little refinement over the small job would be in order.

My experience with theater work has indicated that most patrons will object to air currents on the back of the head and neck, as would probably be obtained with all of the return air intakes at the screen. However, for heating work, it would be desirable to return part of the air at the screen. On the other hand, unless this job is located in a cold climate, the heating requirement is probably small, particularly if the house can be preheated before the show starts.

Personally, I do not like side wall outlets in a theater, preferring overhead distribution. Generally the cost of the distribution system is lower, and certainly it is more effective. With this type of distribution, and with the sloping floor, it appears that mushrooms in the floor, or other type of floor returns, would be a simple solution. Low side wall returns might be the answer. At any rate, I would recommend that part of the return air be taken at the screen, or near the front of the house.

For reasons of economical operation, I would suggest that the equipment be arranged to handle all outside air for the intermediate seasons when outside conditions would be satisfactory under light loads. This certainly would require a separate return air fan, arranged for returning the air to the equipment, or exhausting 100 per cent.
—J. A. E.

ASKS FOR IDEAS ON FILING INFORMATION

You are invited to comment on the following question from "R. A. W." Suitable discussions of this matter will be published, and paid for at regular rates (with additional payment for sketches). Address The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.

"Many engineers and contractors like to keep copies of articles from HPAC and other publications for future reference, and most of them seem to have difficulty in filing them so that it is easy to find the material on a particular subject when the need arises.

"Space is always limited, and if the filing scheme is too complicated a lot of the reference value of the material is lost.

"I'd be interested in knowing how others solve this problem, and how an engineer or contractor can file engineering information without setting up an elaborate library or file room."—R.A.W.

"OPEN FOR DISCUSSION"

We follow here the custom of engineering society meetings in allowing a period for questions, answers, and comment following presentation of a paper. You are invited to contribute your views on published articles, other matters of importance. Address the Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

"LAZY" ZONING CAUSES TROUBLE

REFERRING TO Sam Lewis' Page in the July issue, "lazy" zoning is a familiar crime in laying out heating, ventilating, and air conditionling systems. In connection with subdividing heating systems into zones, we have had wide experience, particularly in connection with installations where we apply our weather-compensated heat regulator. The test that should be applied in deciding upon the extent of a proposed heating zone is "Are the temperature requirements relatively constant throughout the proposed zone and are conditions such as to make it possible to secure a uniform temperature throughout the zone?" If the answer to either of those points is "No," then there must be a different subdivision into zones, or else the designer must make up his mind that he is going to use a suitable high-limit control for the entire building or section of a building, simply to secure a measure of economy and not to achieve automatic temperature regulation.

We may consider all of the usual factors in zoning such as exposure, protection afforded by surroundings (other buildings, topographical protection, the height of the building, etc.), the hours of occupancy, the temperature requirements in various sections, and the layout of the building in question. However, if we fail to ask ourselves the simple, two-part question quoted above, we cannot secure a satisfactory installation from the standpoint of controlling temperatures.

When we get into the subdividing of air conditioning systems into zones, we have exactly the same considerations to take into account. But having worked out a proper zone, we have the additional hazard of uncontrolled sources of heating (and cooling) which will plague us unless we have an opportunity properly to control them, along with the air conditioning. Mr. Lewis has brought out that point very effectively.—J. R. VERNON, Johnson Service Co.

SAM LEWIS' PAGE

"Lazy" Zoning Causes Heating, Cooling Troubles

OUTPUT OF HEATING PANELS

WE ARE ENTIRELY in accord with R. G. Vanderweil in his efforts to point out some of the misleading information that has been published with respect to possible heat emission from radiant heating floor panels.

Some well-known sources state that for residences and offices the heat output from a radiant heating floor panel "should not exceed 60 to 80 Btu per sq ft." This, of course, is true, but we have been unable to find in any of the literature an explanation of the conditions under which these high rates of emissivity from floor panels would be possible.

Two points which a good designer of heating systems should bear in mind, particularly in respect to radiant heating systems, are first to provide comfort conditions and second to provide economical operating conditions. We do not consider the maintenance of high water temperatures as representing economical operation in radiant heating systems, yet the high heat emissions referred to above would require high water temperatures or inclosing room surface temperatures that would not produce comfort conditions and probably could not be maintained without mechanical ventilation.

There is one point of disagreement that we have with Mr. Vanderweil, however, and that is where he speaks (in his article in the July HPAC) of a panel heated room "designed for 70 F." Our point here is that rooms to be heated by radiant heating rather than convection heating should not be designed for any fixed air temperature, for in a properly designed radiant heating system the room air temperature should not be considered as having a constant value as it will vary inversely with the heating load.

Another point in connection with floor panels which might be of interest to a number of readers and which we hope will be covered by some of Mr. Vanderweil's future articles is the matter of pipe or tube spacing with particular reference to the temperature gradient on the floor surface between widely spaced pipe or tube in the coils.—D. L. MILLS, Revere Copper and Brass, Inc.

PANEL HEAT OUTPUT AND TEMPERATURES

THERE SEEMS TO be some room for question concerning several of the statements made under the subheading "Panel Heat Output" in the article by R. G. Vanderweil in the July issue. The author states

Practical Pointers On
RADIANT HEATING DESIGN

two means by which we can obtain greater panel output and if you will read them carefully you will see that he deals solely with surface temperatures. My point here is that convection has either been ignored or taken for granted as a stable factor determinable by purely theoretical methods, some of which date back to departed scientists of European origin. We are studying this convection factor closely and hope to have some useful data in the near future.

Continuing under the subheading "Panel Heat Output," we find a discussion of maximum surface temperature for floor panels. The broad statement, "an 85 F surface temperature seems the only figure the experts will agree upon," requires, in my opinion, considerable more substantiation in terms of documentary evidence before it should be accepted throughout the heating industry as the upper limit for radiant heating systems of this kind. The figure of 85 F has been widely used for a number of years and yet it is interesting to note that the 1947 ASHVE Guide now gives a range of 90 F to 93 F for skin temperature, whereas it is my understanding that a year or two ago this figure was also 85 F. Isn't it reasonable to assume that if we have been in error to the extent of 5 to 8 deg in assuming a figure for skin temperature that we are also in error to approximately the same degree in our conclusions concerning maximum floor surface temperature? Those of us who have made a point of studying radiant heating from a practical point of view have experienced many, many instances of floor temperature in the 88 F to 95 F range and yet I can honestly say that I have not been able to obtain a statement of dissatisfaction under these conditions.

Mr. Vanderweil also makes the statement that "We know that for a given room, the heat output varies with the floor temperature." Just what is intended by this statement I am not certain, for the word "varies" indicated no specific relation. Our test and field work have indicated to us that under certain conditions we can expect such results as heat output increasing both with increases and decreases in floor surface temperature and that heat output can vary without a change in floor surface temperature. These reactions were noted in actual radiant heating systems installed in conventional buildings exposed to outdoor conditions and are not based on laboratory test work.—PAUL S. PARK, engineering service dept., A. M. Byers Co.

Hosiery Manufacturer Finds Many Advantages in Air Conditioning

Signing of "the largest single contract for complete air conditioning in the history of the textile industry," covering the three United States mills of Gotham Hosiery Co., was announced jointly recently by Carrier Corp. and Gotham. The installations will be largely completed this summer in the two mills in Philadelphia and one in Fort Wayne, Ind., at a cost of approximately $500,000, according to Roy E. Tilles, president of Gotham.

Five big centrifugal machines, with a capacity of 1150 tons of refrigeration, will be installed to completely air condition both the manufacturing and office spaces in the three plants. Some textile operators have spent considerably more money in aggregate for air conditioning, but not in any one contract, it is said.

Mr. Tilles emphasized that the system would allow Gotham to produce the sheerest of "Gold Stripe" nylon stockings under the same controlled conditions that prevail in the du Pont plants that produce their nylon yarn.

"Air conditioning will permit us to produce at a cost low enough to retail at $1.95 nylon stockings of a fineness exceeding even the pre-war French made silk stockings which retailed at more than $5.00 a pair," Mr. Tilles said.

The extremely fine stockings now being made on high speed, fine gage machines require production at tolerances so close that abnormal temperatures and humidity cause the yarn to gum and kink, he explained. Moreover, unless temperatures are kept at a predetermined level, the machinery overheats due to friction.

"For several years our research laboratories in Philadelphia have been studying hosiery manufacturing techniques under air conditioned operations," Mr. Tilles said. "These studies and tests proved that proper temperature and humidity control would permit the use of fine yarns, higher speed machinery, and more precise manufacturing processes. By controlling temperature and humidity we get hosiery production that is virtually trouble-free and we produce a finer quality product. We believe that this pioneering step will set the pace in the hosiery industry and that in a few years all large mills will be air conditioned."

In Gotham's two Philadelphia plants conditions to be maintained are 85 deg and 50 per cent relative humidity. In the big knitting building four central station systems will be established to handle a total of 162,000 cfm. The system for each of the four areas will be a spray water type of washer, utilizing either chill water from the cooler or recirculated water from the tank of the washer itself to maintain a constant dewpoint within the washer at all times.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Experimental Studies on Panel Heating Tube Spacing

By B. F. Raber*, Berkeley, Calif. and F. W. Hutchinson**, Lafayette, Ind.

SUMMARY — Conductance of nine 4 x 4 ft test panels (hot water type) was determined for $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ in. of copper tubing spaced on 4, 6 and 9 in. centers. Based on 6 in. spacing as 100 per cent the panel conductance for 9 in. and 4 in. spacing was reduced to 72 per cent and was raised to 154 per cent respectively for the three sizes of tubing used in tests.

In previous panel heating research publications[1] the authors have confined their attention to the influence on thermal environment of a uniformly-heated flat surface located in the ceiling, or floor, or wall. No consideration was given to the mechanism by means of which the surface temperature could be raised to the required value nor to the problem of achieving uniformity of temperature across the surface. This paper differs from the others in that it is concerned solely with conditions behind the heating surface and presents results of a detailed experimental investigation of various sizes and spacings of copper tubing when embedded in plaster and used to convey hot water.

Problem

As elsewhere described,[2] the first problem in the design of a panel heating system is to determine the required panel area for a selected design surface temperature, which will permit carrying maximum heating load. Irrespective of the type of panel to be used—whether energized by electricity, warm air, steam, or hot water—the area and temperature can be fixed in terms of the thermal characteristics of the structure. When a heat balance analysis has been completed it is then possible, from a knowledge of the equilibrium optimum room air temperature and the average temperature of unheated room surfaces, to evaluate the required energy dissipation rate, expressed in Btu per (square foot of panel) (hour), of a panel surface operating at a fixed temperature. Until a heat balance has been established the panel output *cannot* be determined since it depends on two variables—the inside air temperature and the average temperature of unheated room surfaces—which have optimum comfort values that cannot be fixed in advance of analysis. Even in cases where the ventilation rate is so low that the optimum comfort air temperature does not vary greatly with the type of structure, the unheated surface temperature will be found to change so much that variations in panel output—for fixed panel surface temperature and fixed air temperature—will frequently be of the order of 15 per cent.

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Presented at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Coronado, Calif., June, 1947.

[1] Panel Heating and Cooling Analysis, by B. F. Raber and F. W. Hutchinson. (ASHVE Transactions, Vol. 47, 1941, No. 1182, p. 285.)

ASHVE Research Report No. 1192—Panel Heating and Cooling Performance Studies, by B. F. Raber and F. W. Hutchinson. (ASHVE Transactions, Vol. 48, 1942, p. 35.)

Trend Curves for Estimating Performance of Panel Heating Systems, by B. F. Raber and F. W. Hutchinson. (ASHVE Transactions, Vol. 48, 1942, No. 1217, p. 425.)

ASHVE Research Report No. 1252—Optimum Surface Distribution in Panel Heating and Cooling Systems, by B. F. Raber and F. W. Hutchinson. (ASHVE Transactions, Vol. 50, 1944, p. 231.)

ASHVE Research Report No. 1274—Radiation Corrections for Basic Constants Used in Design of All Types of Heating Systems, by B. F. Raber and F. W. Hutchinson. (ASHVE Transactions, Vol. 51, 1945, p. 213.)

[2] Panel Heating and Cooling Analysis, by B. F. Raber and F. W. Hutchinson. (ASHVE Transactions, Vol. 47, 1941, No. 1182, p. 285.)

Consider, for example, an 85 F floor panel of area sufficient to maintain comfort in a structure with optimum inside air temperature of 69 F when outside design temperature is +30 F and ventilation is at a rate of 1 cfh per square foot of room surface. If the equivalent overall heat transmission coefficient for the structure were 0.04 the heat balance analysis[3] would indicate a panel output of 34 Btu per (hr) (sq ft of panel) with an exact optimum inside air temperature a fraction of a degree above 69 F. If, on the other hand, the equivalent overall coefficient were 0.26, the analysis would show a panel output of 39 Btu per (hr) (sq ft) with an exact optimum inside air temperature a fraction of a degree below 69 F. Thus for these two structures unit area of panel operating with fixed surface-to-air temperature difference of 85 — 69 = 16 would have outputs differing by approximately 14 per cent. If, in such an instance, the design were based on the assumption that the rating of the panel in a comfort installation is fixed in terms of the panel surface temperature the resultant error in determination of requisite panel area might be as much as 14 per cent.

The above analysis indicates that an "overall" correlation of panel ratings in terms of water-to-air or surface-to-air temperature differences is irrational and unlikely to lead to dependable coefficients. A more striking demonstration of the same fact is that a floor panel operating at a fixed temperature dissipates 50 per cent more energy than a ceiling panel operating at the same surface temperature. Hence it is deduced that an analysis of the thermal environment in a comfortable room must end at the surface of the panel, whereas analysis of the mechanism of bringing energy from the source (as water in a tube) to the panel surface must start not in the room air, but at the panel surface.

Specifically, therefore, the problem of panel rating is visualized as requiring the determination of a conductance rather than an overall heat transfer coefficient; the conductance of the panel from the water within the tubes to the panel surface. Thus if t_w and t_p are taken, respectively, as the average temperatures of water passing through the coil length associated with unit panel area and the average surface temperature of that unit area, and if Q_p is the output of unit area expressed in Btu per hour, then the panel conductance, C, will be defined by the equation,

$$C = Q_p/(t_w - t_p) \quad \ldots\ldots\ldots (1)$$

Since the conductance does not include conditions exterior to the panel it follows that for fixed values of t_w and t_p the experimentally determined value of C for a particular tube size and tube spacing should have a fixed value independent of the location (as floor, wall, ceiling) of the test unit.

Method

The panel test station was set up inside the air conditioning research rooms at the University of California; these rooms, described in a previous paper,[4] are themselves located within a large laboratory structure. Air within the research rooms could be maintained at any desired temperature between 40 F and 140 F with ventilation at any selected rate between zero and fifteen air changes.

To permit exact duplication of procedure for panels using various sizes and spacings of tubing a standard size of 4 ft x 4 ft was selected for each test section. Fig. 1 is a rear view of a representative test panel prior to application of the plaster. Coils were located *above* the metal lath and each panel was contained within a 2 in. x 4 in. wooden frame with steel supporting cross-bars from which the coil and plaster were suspended. Back-plastering assured complete embedment of the coils. Plastering was done in the usual way, but under controlled conditions so that the uniformity of the work was much greater than that usually found in practice. Fig. 2 shows a front view of the test surface of a typical test panel.

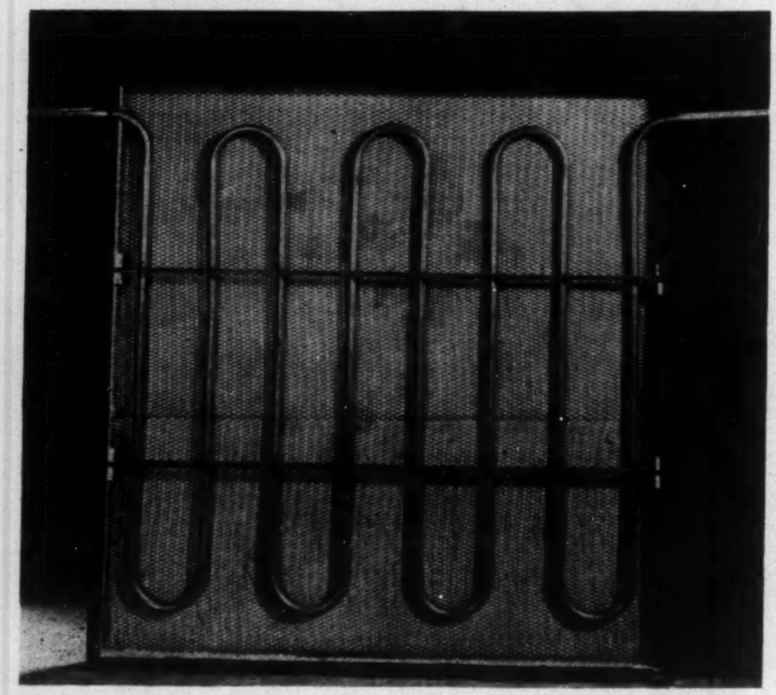

Fig. 1—Rear view of representative test panel prior to application of plaster

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[3] Trend Curves for Estimating Performance of Panel Heating Systems, by B. F. Raber and F. W. Hutchinson. (ASHVE TRANSACTIONS, Vol. 48, 1942, No. 1217, p. 425.)

[4] ASHVE RESEARCH REPORT No. 1192—Panel Heating and Cooling Performance Studies, by B. F. Raber and F. W. Hutchinson. (ASHVE TRANSACTIONS, Vol. 48, 1942, p. 35.)

The test station consisted of a 6 ft x 6 ft x 8 in. cork block, finished on the bottom and sides with plywood and with a 4 ft x 4 ft x 4 in. pocket in the bottom into which the various standard size test panels could be inserted. The cork block was supported on pipe legs at a distance of 8 ft from the floor, thus constituting a 36 sq ft element of hung ceiling with an inserted 16 sq ft heating panel. Heat losses from the sides of the test unit were thus retarded by 12 in. of cork, whereas a 4 in. cork barrier retarded losses from the rear of the panel. Fig. 3 is a photograph of the test station taken, looking up, from the floor of the air conditioning research room. The white central section is the heated ceiling surface and the six inch vertical lip shown around the plywood-finished cork box is a barrier intended to prevent heated air from sliding out from under the test panel and rising to the room ceiling. Twenty-eight thermocouples are shown attached to the test surface as also is a 4 in. x 4 in. Gier and Dunkle heat meter.

Because of the fact that it was desired to run tests with widely different flow rates, a decision was reached to use a once-through flow circuit with water from the test panel going through a weighing tank and then to discard in the building drain. Cold water from the city system flowed continuously through a standard residential gas-fired hot water heater, leaving at a temperature a few degrees lower than that desired at the panel and discharging from the heater to an open 100 gal tank which was located on top of the research rooms. Electric immersion heaters, under automatic control, raised the temperature in the tank to the desired value and maintained it at a fixed setting within 1/5 F deg; mechanical agitation was used to assure uniformity of temperature throughout the mixing tank.

From the mixing tank flow occurred by gravity down to the research room, through the test coil and into the weighing tank; a valve in the line at discharge from the test panel permitted control of the flow rate with exact adjustment by means of a needle valve located in a bypass around the main valve. Temperature of the water to and from the test coil was determined by oil-immersed calibrated mercury thermometers (one-tenth degree least count) and checked with copper - constantan thermocouples. Thermocouples located at intervals in the cork block were used to check the temperature gradient through the side and rear insulation and these calculations were checked by means of direct heat meter readings from the exposed surfaces of the insulation.

Nine test panels were constructed using ⅜, ½, and ¾ in. Type K copper-tubing on 4, 6, and 9 in. centers. As shown in Figs. 1 and 2, all panels were of the sinuous coil type and supply and return connections were arranged to protrude through prepared openings (sealed with ground cork) in the block of insulation. Because of the not inconsequential weight of the test sections the cork block was arranged so that one section could be removed (1 ft x 4 ft piece in the foreground of Fig. 3) to permit hoisting the test specimen to the required elevation and then sliding it into place on rails built into the insulation. Prior

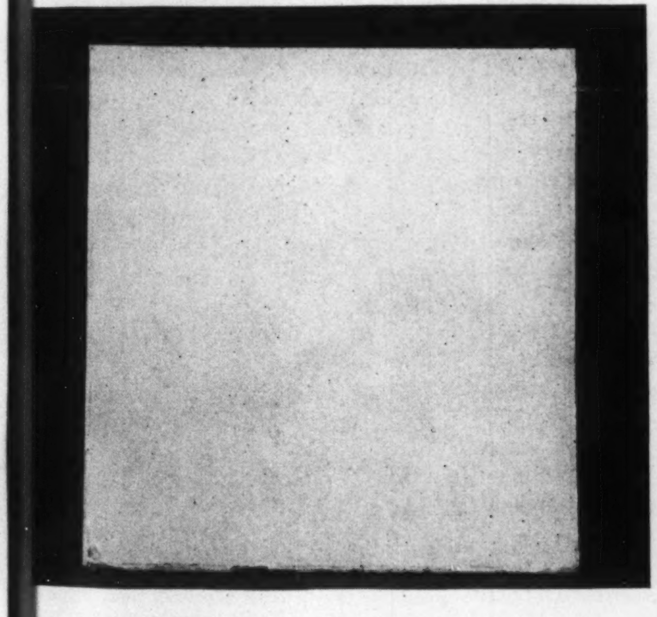


Fig. 2—Front view of test panel surface

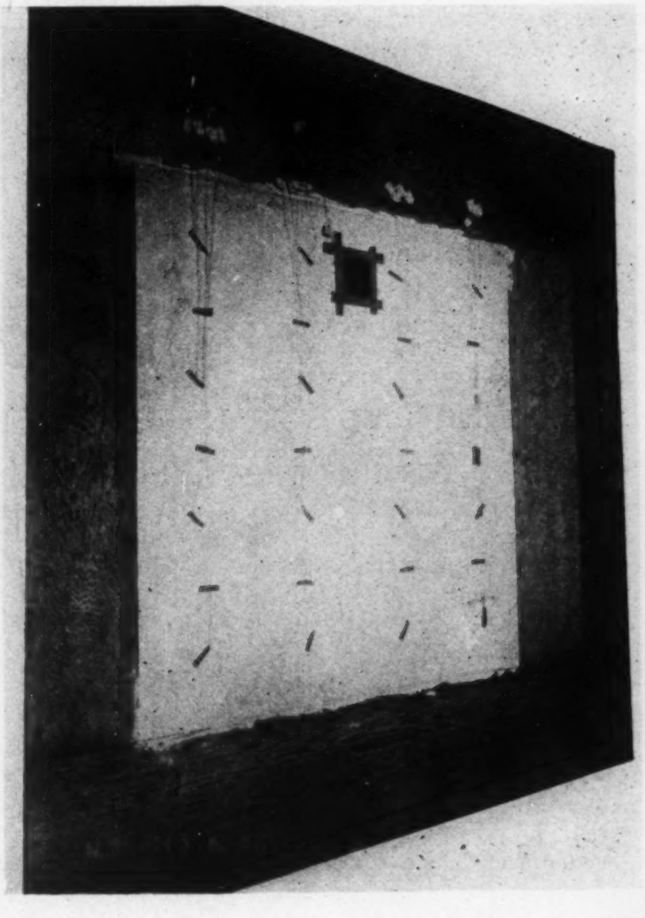


Fig. 3—Bottom view of test panel located in ceiling

to testing, each unit panel was sealed into the insulation by filling the small cracks (approximately ⅛ in.) that had been left to provide clearance between the panel and the cork block.

Data were recorded for three identical tests on each of the nine panels and in no case was a record made until a minimum of 24 hours after test conditions had been impressed on the panel and a separate minimum of 6 hr after the last evidence of transience. To avoid the possibility of error through inadvertent change in the method of installing or sealing the panels, the three tests on each type of panel were not run in progression, but three complete sequences of nine tests each (covering all panels in each sequence) were made. In addition to the nine plaster panels, units were also constructed with coils embedded in concrete and coils standing in free air back of a plywood surface; one unit consisted of a coil in loose sand (back of plywood) and others used tube sizes greater than ¾ in., but neither the number of test panels of a given type nor the number of check tests on these nonplaster units were great enough to warrant inclusion of the results in this paper. Specifically, therefore, the results given in this paper are limited to three sizes of tubing on three spacings for sinuous coil, copper tube, hot water panels.

Results

For equilibrium conditions the energy loss from the sides and the rear of the test panel was found to be insignificantly small. Thus the desired experimental result, the conductance C, could be evaluated from four experimentally determined values. These are: (1) the temperature t_{wi} of the water at entrance to the test coil; (2) the temperature t_{wo} of water leaving the test coil; (3) the flow rate, W, expressed in pounds per hour; and (4) the surface temperature of the test panel, t_p. The first three of these values were determined by direct observation (from mercury thermometers and weighing tank), whereas the fourth was taken as the average of the 28 thermocouple readings. Noting that the mean water temperature, t_w, is the arithmetical average of t_{wi} and t_{wo} and substituting into Equation 1,

$$C = \frac{2W\,(t_{wi} - t_{wo})}{A_p\,[(t_{wi} + t_{wo}) - 2t_p]} \quad \ldots (2)$$

where

C = Conductance, Btu per (sq ft of panel) (hr) (F deg difference between average temperature of water in coil and average surface temperature of panel)

W = water flowing through coil, lb per hr

t_{wi} = temperature of water entering coil, F deg

t_{wo} = temperature of water leaving coil, F deg

t_p = temperature of surface of test panel, F deg

A_p = area test panel, square feet

Table 1 gives the resulting values of C for the nine test panels.

Taking ½ in. tube on 6 in. centers as an arbitrary standard, the value of C for this test panel was found to be 1.55 Btu per (hr) (sq ft) (F deg). Tests of the same spacing with tube sizes of ⅜ in. and ¾ in. gave C values less and greater, respectively, by 2½ per cent. The absolute values of the conductances for panels with tube spacings other than 6 in. were not the same, but the percentage change in conductance due to increasing the size from ½ to ¾ in., or in decreasing it from ½ to ⅜ in. was, for all three spacings, found to be practically equal to 2½ per cent. Thus it appears from these tests that tube size, within the range from ⅜ to ¾ in., has no appreciable effect on the rate of energy dissipation from panels using sinuous coils with spacings of 4, 6, or 9 in. On the basis of Btu transferred per pound of copper, the smaller size tubing evidently has a substantial advantage. In practice, however, a selection of tube size must be tempered by other considerations such as pressure drop, maximum permissible temperature difference between entering and leaving water, uniformity of panel surface temperature (which may have a definite influence on the life of the plaster) and other considerations.

For fixed tube size and variable spacing it was again found that a single correlation applied to all three sizes. Taking 6 in. spacing as an arbitrary standard, the value of C was found to be reduced to 72 per cent when the spacing was increased to 9 in. and raised to 154 per cent when the spacing was reduced to 4 in. Expressed differently, the transfer rate per lineal foot of tubing was 100 per cent when centered at 6 in., 2½ per cent less for 4 in. centers, and 7 per cent greater for 9 in. centers. As a very rough approximation (accurate to 90 per cent) the transfer rate, over the range considered, was essentially independent of both spacing (as such) and tube size and retained a fixed value of approximately 0.77 Btu per hour per *lineal foot* of tube per 1 F deg temperature difference between water and panel surface.

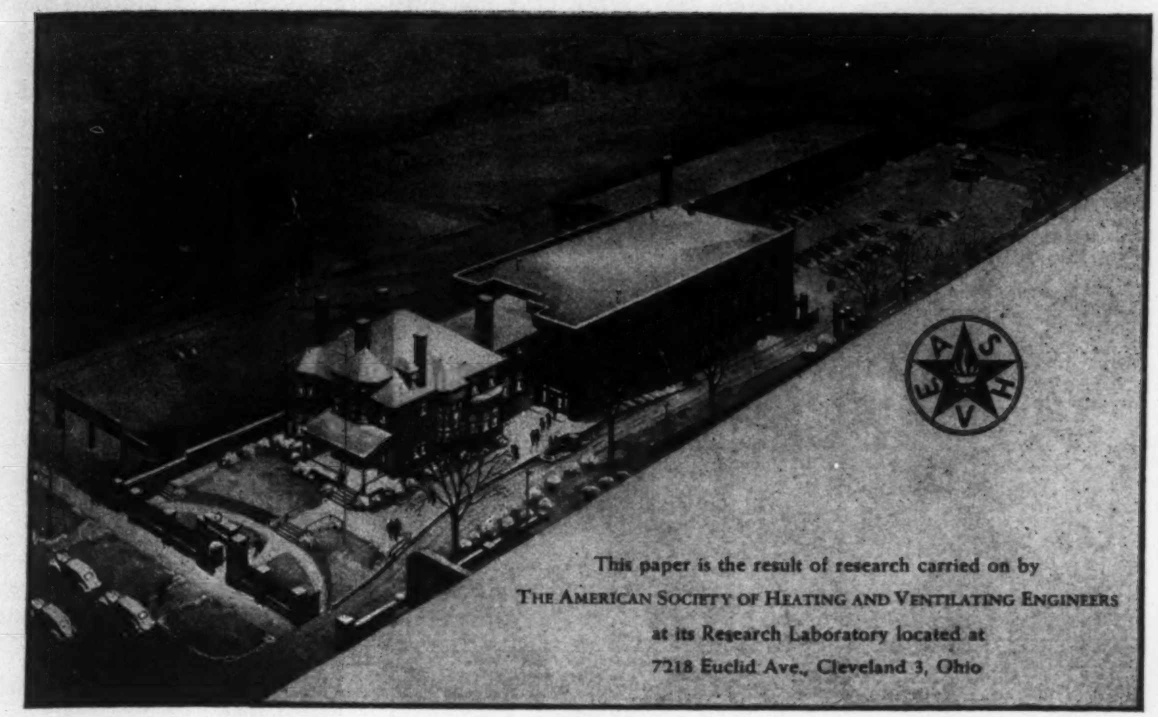
Conclusions

When a panel heating design problem has been attacked by the heat-balance method, the designer obtains as part of his answer the required area of panel which, for design conditions, must operate at the design maximum surface temperature. An additional piece of information available from the heat balance analysis is the required heat output, expressed in Btu per (sq ft) (hr) of the panel. As a first, and usually conservative, approximation it is suggested that the known panel rating be divided by 0.77 to obtain a number which can be taken as equal to the product of the water-to-surface temperature difference and the required lineal feet of tubing per square foot of panel. Now either the water temperature can be arbitrarily fixed and the tube spacing calculated, or vice versa.

Table 1—Results of Thermal Conductance[a] Tests of 9 Sinuous Coil, Type K Copper Tube Plaster Panels

Tube Diam. In. OD	Spacing of Tubes (Center to Center) In. 4	6	9
⅜	2.32	1.50	1.07
½	2.39	1.55	1.11
¾	2.48	1.60	1.15

[a] Btu per (hr) (sq ft of panel surface) (F deg temperature difference between mean temperature of water in the coils and the average surface temperature of the panel)



This paper is the result of research carried on by
THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
at its Research Laboratory located at
7218 Euclid Ave., Cleveland 3, Ohio

Heat Transfer by Forced Convection Along A Smooth Flat Surface

Laminar and Transitional Boundary Layer Flow

By G. V. Parmelee* and R. G. Huebscher**
Cleveland, Ohio

SUMMARY—This is a report of an investigation of forced convection heat transfer into the laminar and transitional boundary layer along a smooth flat surface.

Data obtained were used to evaluate dimensionless numbers representing flow conditions and the heat transfer process. A plot of these dimensionless terms was in good agreement with curves representing the closely allied phenomenon of skin friction.

THE TRANSFER of heat by forced convection at the exterior surfaces of buildings is a factor in calculations leading to the design of heating and cooling systems and apparatus. In estimating steady state heat flow through walls of relatively low conductance, the convection coefficient is usually of secondary importance. It is of primary importance, however, in treating periodic heat flow as it is influenced by weather elements, especially solar radiation. And it is of great importance in calculating heat flow through building elements, such as glass, which have relatively high thermal conductances. Outside the field of heating and air conditioning many examples can be cited of technical problems in which convection heat transfer from flat surfaces is involved.

Recognizing the importance of this problem in the general area of heat transmission through windows, the ASHVE Research Technical Advisory Committee on Glass,† early in 1945, formulated a program of research on forced convection heat transfer from flat surfaces. Included in this program was an investigation of forced convection heat transfer from flat surfaces, the particular objectives of which were to study the effects of air movement and of such surface characteristics as length, the presence of transverse ribs (such as muntins) on otherwise smooth surfaces, and the recessing of the glass below the surrounding surfaces.

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**Assistant Research Engineer, ASHVE Research Laboratory.

Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Coronado, Calif., June, 1947.

†R. A. Miller, *chairman;* A. B. Algren, J. E. Frazier, J. S. Herbert, E. H. Hobble, L. K. Jones, C. O. Mackey, F. Preston, W. C. Randall, Vic Sanders, H. B. Vincent, G. B. Watkins.

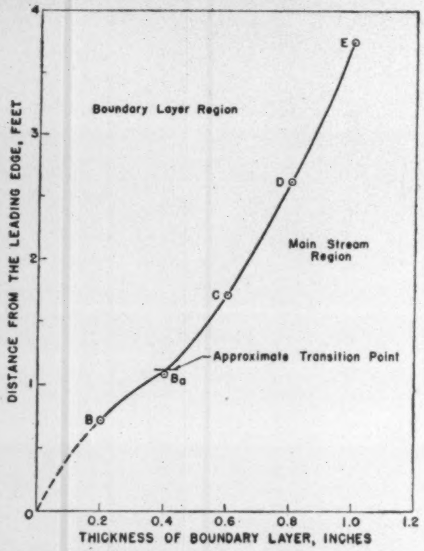

Fig. A—Boundary layer contour along the heated surface

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Scope of the Investigation

This paper presents data on forced convection heat transfer into laminar and transitional boundary layer flow along a smooth flat surface. The term transitional flow describes the condition wherein the velocity distribution is laminar in the boundary layer along that portion of the heat transfer surface nearest the leading edge and turbulent in the boundary layer along the remainder of the surface.

Data on heat transfer into a wholly turbulent boundary layer have previously been published.[1]

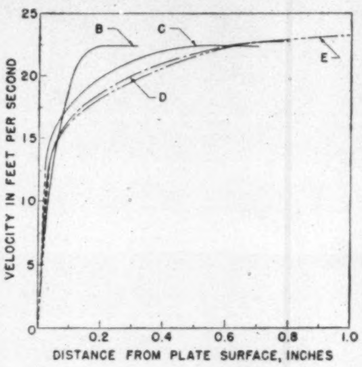

Fig. B—Velocity distribution in the boundary layer at several points along the heated surface

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Heat Transfer and Air Flow Along a Flat Surface

A system in which air flows parallel to a smooth flat surface will be considered. At the leading edge, viscous drag between the air and the surface retards a thin layer of air. As the air proceeds along the surface, additional layers are similarly affected. Meanwhile the main stream is relatively unaffected. That portion of the air stream in which the velocity is less than that of the main stream constitutes what is called the boundary layer. The thickness of this layer is dependent upon the velocity distribution, the distance from the leading edge, the air velocity, and the air properties.

Fig. A shows in a general way the variation in thickness of the boundary layer as found in one of the tests described in this paper. It

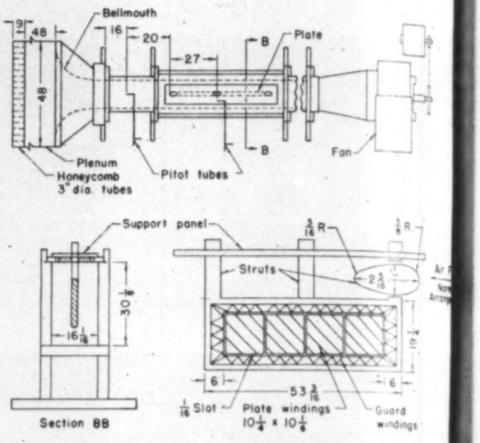
Bellmouth
Plate
9
48
16
20
27
48
B
B
Plenum
Honeycomb 3" dia. tubes
Pitot tubes
Fan
Support panel
$\frac{3}{16}$ R
$\frac{1}{8}$ R
Struts
$2\frac{3}{16}$
$30\frac{1}{8}$
$16\frac{1}{16}$
$19\frac{1}{4}$
6
6
$53\frac{3}{16}$
$\frac{1}{16}$ Slot
Plate windings $10\frac{1}{4}$ x $10\frac{1}{4}$
Guard windings
Section BB

Fig. C—Details of wind tunnel and heated plate

●

Fig. D—Wind tunnel and equipment assembly

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[1] Exponent numerals refer to Bibliography.

Table 1—Summary of Test Results
Leading Edge Radius 3/16 in.

Test No.	*h*	*L*	*V*	Temperature F Air	Temperature F Plate
31	1.12	1.19	2.8	76.5	97.1
30	1.29	1.19	4.1	76.0	94.1
29	0.98	2.04	4.4	80.5	103.0
28	1.21	2.04	6.8	80.0	98.6
27	1.45	2.04	10.1	81.0	96.7
26	1.94	2.04	15.6	81.1	92.8
32	2.63	2.04	19.5	80.9	97.8
33	3.45	2.04	23.4	79.1	92.0
34	4.16	2.04	27.4	80.3	91.6
35	4.86	2.04	31.2	81.9	91.0
36	3.79	2.91	24.9	83.6	95.5
37	4.49	2.91	27.9	79.0	89.1
22	3.04	3.75	20.5	82.9	115.8
39b	3.26	3.75	22.8	80.9	94.3
20	3.64	3.75	26.2	79.7	107.8
21	3.87	3.75	26.4	78.1	104.2
38	4.11	3.75	27.8	83.7	94.5
19	4.49	3.75	30.9	82.2	107.1
18	6.24	3.75	43.2	81.5	99.7
23	6.24	3.75	43.3	79.5	96.5

h = heat transfer coefficient, Btu per (hr) (sq ft) (deg F)
L = length of heated surface, ft, excluding the nose piece
V = air velocity, fps, measured midway between the plate surface and the tunnel wall and halfway along the length of the surface

also shows where, in this particular test, the transition from laminar to turbulent flow took place. Fig. B shows the velocity distribution in the boundary layer along the plate in the same test as in Fig. A.

The process of heat transfer is largely confined to the boundary layer. The unit rate of heat transfer, or the film conductance, will therefore vary from point to point along the surface and will be related to the velocity distribution within the boundary layer.

Experimental Procedure

Essentially the apparatus consisted of a smooth flat plate about 53 in. long, electrically heated and suspended in the center of a rectangular draw-through type wind tunnel 16 in. wide, 30 in. high, and about 12 ft long (Fig. C). The wind tunnel and equipment assembly are shown in Fig. D.

In order to reduce radiation corrections to a minimum, the plate surfaces were made of smooth polished sheets of aluminum. By sectionalizing the plate (Fig. C) the rate of heat transfer from each of four areas could be measured separately. Electrically heated guard areas around each test area eliminated edgewise heat flow.

Surface temperatures were measured by sixty thermocouples embedded in the under sides of the plate surfaces. Air temperatures were measured in front of the leading edge.

The velocity of the air could be adjusted as desired over a range of about 2 mph to 40 mph (180 to 3600 fpm).

In the tests reported[1] previously the leading edge of the plate had radii of 3/8 and 15/32 in.; the tests described here were made with a leading edge radius of 3/16 in. and a more gradual taper. These details are mentioned because it was found that the entry conditions greatly affected the boundary layer and therefore the heat transfer coefficient.

The Results Obtained

Table 1 lists the principal data obtained during the course of the experimental work. These data were used to evaluate dimensionless numbers representing the flow conditions and the heat transfer process. These dimensionless numbers also include other variables, namely, air density, specific heat, specific thermal conductivity and viscosity, which, in this investigation, varied only to a small degree. A plot of these dimensionless terms was in good agreement with curves representing the closely allied phenomenon of skin friction.[2]

Based upon the correlation of the data with friction curves and for conditions of 70 F air at 14.7 psi, curves are presented in Fig. E, which include only the two principal variables, length and air velocity. Curve A closely represents the data previously obtained for a turbulent boundary layer flow. Curves B and C represent the data of Table 1, except that density and temperatures prevailing during the tests were lower and higher respectively than the bases on which these curves were constructed. Radiation effects must, of course, be treated separately. This form of plotting makes it possible to select the average heat transfer coefficient, *h*, when the two variables, surface length and air velocity, are known. The term *h*/(mph) is found from the appropriate curve for a given value of air velocity in miles per hour times surface length, *L*, in feet. This multiplied by mph gives the heat transfer coefficient. The test data covered mph × *L* for the range 3 to 200.

The significance of the curves is best understood by considering the air velocity to be a constant and length a variable. Curve A shows that for turbulent flow the average coefficient decreases as length (or the Reynolds number) increases. This is also true if the flow is laminar, but the coefficient is much lower for a given length.

However, the laminar boundary layer cannot be maintained beyond a certain point at which the flow changes to a turbulent pattern (Curve C). This change (at mph × *L* equals 16.5 or 150,000 Reynolds number in these tests) causes at first an increase in the heat transfer coefficient, but later, as will be seen from Curve C, the heat transfer coefficient tends to decrease as the length increases still further.

For a constant length, the effect of air velocity is, of course, to increase the heat transfer coefficient. The effect of velocity is greater in turbulent flow than in laminar.

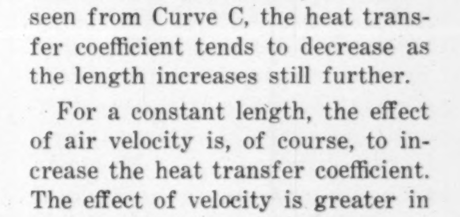

Fig. E—Relationship between average heat transfer coefficient, air velocity and length of heated surface

Discussion of Results

The data for heat transfer in the laminar boundary layer showed natural convection effects up to the transition point in spite of efforts to suppress such effects by using very low heat inputs. In order to evaluate the dimensionless numbers, therefore, an approximate correction was derived and applied. Corrections were also derived and applied to account for the heat transferred into the air stream from the guard surface, which lay between the leading edge or nose piece and the actual test section.

The transition point was estimated from the heat transfer data and supported by total pressure traverses[3] of the boundary layer. The significant factor determining the location of the transition point was the bluntness of the leading edge, since the surface smoothness and large scale turbulence of the air stream were identical with the test conditions described in an earlier report.[1] The air stream turbulence was evaluated by sphere tests and found to be 1.5 per cent.

In the literature on heat transfer from flat surfaces few data were found for the flow conditions similar to those described in these tests. Elias[4] studied heat transfer from a 1.64-ft long surface with a tapered unheated, 4 in. long leading edge. He computed the heat transfer coefficients by means of measured velocity and temperature distributions in the boundary layer. This data showed a trend similar to Curves B and C, although definiteness was lacking because of scattering of the points.

Fage and Falkner[5] used electrically heated platinum foil strips ranging in length from 0.33 to 1.29 centimeters (0.13 to 0.51 in.). Their data, therefore, were much below the range of velocity times length employed in the tests reported here. Their data, though about 25 per cent above Curve B, had the same slope.

Jakob and Dow[6] have measured rates of heat transfer from a 1.3-in. diameter cylinder placed lengthwise in the jet from a nozzle. They investigated the shape of the leading edge condition and the effect of unheated entrance length. Their data for a laminar boundary layer flow were in agreement with the data reported here, though theory indicates that they should be about 10 per cent greater.

Complete details of this study and the studies reported previously will be published in an ASHVE RESEARCH BULLETIN. Additional literature references will be given together with a comparison of data from several sources.

Summary

While the majority of cases of forced convection heat transfer from flat surfaces, such as glass, involve turbulent boundary layer flow rather than laminar, the results presented here are not without significance.

The shape of the leading edge has been shown to have an important effect on flow conditions and hence on unit heat transfer rates. For example, it is possible that if in heat exchanger design, extreme care is taken to reduce pressure losses, laminar boundary layer flow might result with a consequent reduction in the heat transfer coefficient.

The presence of natural convection effects at low flow velocities in the laminar region suggests that these effects may be also significant at low velocity in the turbulent region. Though this effect was not noticeable in the lowest velocities (10 fps) used in the tests reported[1] previously, it has been reported elsewhere[7] in the literature. This effect has such practical significance in heating and air conditioning problems that it is currently being investigated at the ASHVE Research Laboratory.

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ASA CONSIDERS METRIC PROPOSAL

The *ASA* is currently considering a proposed bill fixing the numerical relationship between the inch and the millimeter. The ratio proposed for the inch is 1 in. = 0.0254 meter.

It also carries a supplementary definition of the inch in terms of light waves, based upon the value adopted some 10 years ago by the International Committee on Weights and Measures. Defined as the number of wave lengths of the red radiation of cadmium in a meter, this value is well supported by several independent determinations.

This legislation was instigated by the Navy Department, since difficulties were experienced during the war in meeting the demands of foreign business and in connection with the need for metric equivalents in certain classes of specifications and standards.

The *ASA* is cooperating with the director of the budget, to whom this bill has been referred, to ascertain industry's viewpoint.

Baldwin M. Woods
President of ASHVE

Coronado Meeting Topics Stimulate Discussion

PRES. Baldwin M. Woods, Berkeley, Calif., opened the Society's Semi-Annual Meeting 1947 in the ballroom of the Hotel del Coronado, Coronado, Calif., June 2.

As the technical sessions were reported only briefly in the July JOURNAL SECTION, *Heating, Piping & Air Conditioning*, a more detailed record of the proceedings is given.

The first technical session was conducted by A. E. Stacey, Jr., second vice president, Syracuse, N. Y., who introduced Cyril Tasker, director of research, Cleveland, as the first speaker. Mr. Tasker spoke as follows:

The Challenge of the ASHVE Research Program

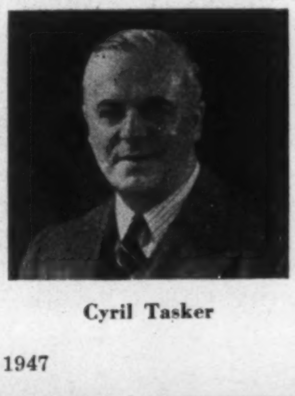
By Cyril Tasker, Director of Research

The Challenge of the ASHVE Research Program can perhaps be considered under two headings. (1) How have we reached the position in which we stand today? (2) What is there before us? What are we doing to justify the title *"Engineers of Human Comfort?*

Early History

It may be of some help in understanding our present position if we examine the early challenges presented to the Society. Since there are very few here who were members of the Society when the Research Bureau was first set up, you may not have ready access to the TRANSACTIONS where the early discussions are on record.

At the 23rd Annual Meeting held in New York in 1917, it was resolved that, "A Committee be appointed to investigate the possibility of establishing a Research Laboratory. . . ." This Committee reported in July 1917 that it believed the time had arrived when the Society needed a Research Laboratory. Six months later it reported that there was no question that the heating and ventilating industry was "greatly in need of specific determinations bearing upon the coordination and standardization of the practices of the art, and that the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS was the proper organization not only to perform some of this work, but to assume the direction and encouragement of such of this work as should properly be done by others." The Committee felt that the Society itself, "was in need of some fundamental common cause upon which the energies and interests of its members could be centered and which would increase the vigor and health of the Society and place it in the position which it should occupy among the affairs of men."



Cyril Tasker

Outline of First Program: Six months later they gave the following outline of the work to be undertaken immediately:

1. The defining of proper heating and ventilating conditions, and the determination of the best methods of maintaining such conditions in homes, public buildings, and factories.
2. Determinations which would tend to place some of our most commonly used methods of heating and ventilating, such as the warm air furnace system, on a more scientific basis.
3. Determinations of the most efficient methods of burning all kinds of fuel in house heating apparatus.
4. Determinations of a more scientific basis for the standard factors connected with the art of heating and ventilating, such as the heat loss through various building materials, number of natural air changes in various types of buildings, the efficiency of various kinds of radiation under various conditions of use, pipe size factors for different types of heating

systems, factors for air duct designs, etc.

5. Determinations of more scientific methods for meeting some of our unusual heating and ventilating conditions, such as those connected with modern tall office buildings, modern large factory buildings and buildings requiring intermittent service, as compared with those requiring continuous service.

Reading this list after almost 30 years, can we feel that this entire program has been completed?

Formation of Laboratory: The Laboratory was first set up in the Bureau of Mines, Pittsburgh, Pa., with John R. Allen as the first director, taking up his duties on October 1, 1919. The budget for the first year was $20,000.

From the first the Society's relationships with the U. S. Bureau of Mines were cordial and today officers of the Bureau are among our staunchest friends.

The Challenge in 1925

Like most new movements, the research activities of the Society got off to a flying start, made possible to a large extent, by the financial support of members and friends in the industry who covered the expenses for the first years by wholly voluntary contributions. Reporting in 1923 as chairman of the Committee on Research, the late Thornton Lewis said that as a national society the members could congratulate themselves that in originating and carrying on the work of the Research Laboratory, real pioneering was being done.

Probably not even the chairman realized how much pioneering was then being done. At the 1923 meeting the late Dr. F. C. Houghten and Dr. W. J. McConnell first reported on their investigations into physiological reactions to high temperatures and humidities. At the same time Houghten and Yaglou presented the paper entitled, Determining Lines of Equal Comfort. At this meeting we shall hear more about the comfort zone, and even something about a discomfort zone, thus illustrating one of the fascinations of research. The answers we get are sometimes not the final, complete and unchangeable answers after all.

In 1924 W. H. Driscoll, then chairman of the Committee on Research, placed before the members the financial position facing the Laboratory. The end had come of the five-year period of pledges to support the work, and means were being sought to ensure its permanent operation. The Laboratory, he said, had become *the bone and sinew of the Society*, and they were not going to let it die. He reported that he had received almost 800 replies to a letter he had sent to the membership. All showed enthusiasm, and member after member had written to say that if the Laboratory shut down they were through with the Society.

Manufacturers who had supported the Laboratory for the first five years had been asking what the Society itself was doing to maintain it. Some had asked what was the practical value of the research reports and had said, "what does this research material amount to, why don't they put it in some form so that we can use it?" Mr. Driscoll's reply was that this was not a function of the Laboratory and that the investigators were not men who were up against the practical problems that the engineers and salesmen in the industry were up against, but were working to dig out the facts that were needed. It is up to you and me, he said, with practical minds to fashion these to our own needs and to make them of practical, usable and workable value.

Research Fund Established

It was at this meeting that Mr. Driscoll made what is perhaps still the greatest challenge ever made to the members of this Society. He proposed that the yearly dues, which were then $15, be increased by $10 a year, the whole of the increase to be deposited in the research fund and devoted exclusively to research purposes. At that time there were about 1650 members and associate members.

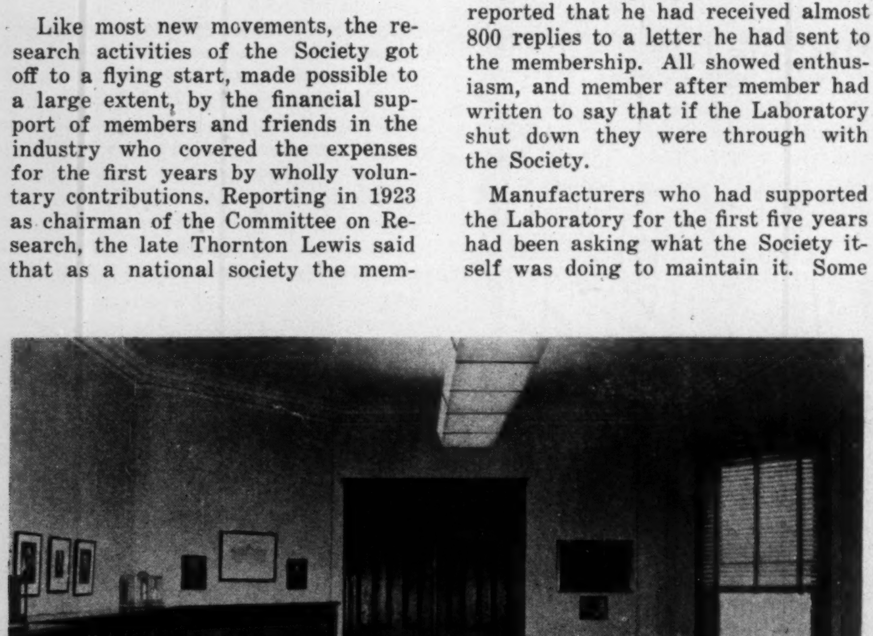
This proposal was approved and became at once a challenge to the membership to support research for the good of all, and a challenge to the members of the Laboratory staff to meet the needs of the membership. It certainly set the Society apart in that no other organization either then or since has such a rule or has so continuously supported basic research work. Here was the *fundamental common cause upon which the energies and interests of the members could be centered,* which formed one of the most important recommendations of the first Committee on Research.

An examination of almost 250 research papers in the TRANSACTIONS of the Society between 1925 and 1941 will show some of the results of the decision made in 1925.

The Challenge of the War

During 1940-41, the major part of the Laboratory's facilities and personnel was engaged in projects relating to national defense. Many studies made for the Navy Department and other branches of the government were treated as confidential material until released for publication after the period of emergency had passed.

At the 48th Annual Meeting, January 1942, the Officers and Council offered, without expense to the people of the United States through its government, the full use of all Society research facilities including the specially trained personnel of its Laboratory. Dr. Houghten, then director of the Laboratory, was commissioned in the U. S. Naval Reserve, and



View of Library and Conference Room at ASHVE Research Laboratory

throughout the war the Laboratory answered all calls for help from the Armed Services or any other department of the government.

The Challenge in 1943

Great progress was made during the war years in the practical application of the results of scientific research in our field. Control of environmental conditions had become essential in many manufacturing processes. A better understanding of the various factors that influence health, fatigue, output and efficiency became essential in order to get the best out of the machines which the ingenuity of engineers had produced.

The Committee on Research and the Council decided, therefore, that to keep pace with the increasing importance of the industry the research activities of the Society should be expanded. It was decided to appoint a Director of Research and engage a competent experienced staff. New and more commodious quarters for the Laboratory were required and a long-range program of research had to be developed. There are many to whom great credit should be given for these steps.

The Laboratory was moved to temporary quarters in Cleveland in the spring of 1944, and in spite of an acute shortage of scientific personnel, new programs were developed and put in operation. As 1945 opened, the Committee was faced with research programs developed by some 20 technical advisory committees involving over 300 members of the Society. At the year's end, work was actively under way at the Laboratory and at a number of cooperating institutions. The question of a permanent home for the Laboratory was under study by a special housing committee.

At the 52nd Annual Meeting, approval was given for the purchase of the quarters now owned and occupied by the Society as the focal point in its research operations. Thus, in April 1946 one of the hopes of those who had set ASHVE research in motion in 1919 was fulfilled.

The annual reports of the Committee on Research which appear in the ASHVE JOURNAL SECTION, *Heating Piping & Air Conditioning*, give details of the various projects under investigation each year. Copies may be obtained from New York or Cleveland on application.

The Challenge of Today

Air Flow

Perhaps the challenge facing the Laboratory today can best be considered under a number of broad headings. We can begin by considering the general subject of air flow.

To a large extent an air conditioning system is judged by the way in which the air distribution is effected; no explanations can counteract a bad draft condition. Air friction in ducts and fittings is of primary importance in any air distribution system and is of fundamental importance to the design engineer. Accurate and dependable data would reduce the necessity for liberal factors of safety. Improvement in design should reduce both the time and the difficulties of elaborate balancing tests to insure satisfactory working of the system.

At the Laboratory, we are making rapid progress in a study of friction in runs of straight circular and square ducts. Shortly we shall be working with rectangular ducts. Primarily these studies are being made to recheck the theory of equal friction for equal hydraulic radius and to test the accuracy of the present tables for circular equivalents of rectangular ducts.

There are almost innumerable types of through-flow fitttings in use today. As soon as we have completed our work on straight ducts, we shall turn to typical elbows and other fittings in which all the air flows through the fitting. Plans are also being made for work on branch-type fittings, to be undertaken as a cooperative research project. A glance through the available literature will show the urgent need for this work.

What do we know about the fundamentals of air distribution, the behavior of ventilation jets, and the performance of the many types of outlets now on the market? Some of these factors are now being studied under a cooperative project at Case Institute of Technology. Judging by the previous work of Professor Tuve and his collegues, not only interesting but valuable data will result from this work.

At Kansas State College, also under a cooperative agreement, the phenomena associated with the downward projection of heated air streams are being studied. Anyone who has tried to analyze the performance of such a stream will have no illusions as to the complexity of this problem. Commencing with mathematical analyses of stream patterns for two widely spread sets of conditions at an orifice, relatively simple forms of equations have been developed for the maximum downward blow and the diameter, velocity, and temperature of the stream at any level. Tests have been made with both a straight pipe and a converging nozzle to project the air; the findings will be given shortly.

Another study at the Laboratory is concerned with the flow of heated gases in flues and chimneys. We have been studying the effect of devices which are popularly known as barometric dampers on such flow and on combustion conditions within a furnace. Though widely used, little is known of the effects produced by such equipment. Early work has been concerned to a large extent with the mechanics of the dampers. The work is tied in with an interest in chimney performance since far too little is generally known about the effect of chimney characteristics upon the performance of heating appliances. Our work is attempting to fill at least one of the gaps in the knowledge.

Industrial Ventilation

In the field of industrial ventilation two papers have been presented within the last 12 months, one on energy

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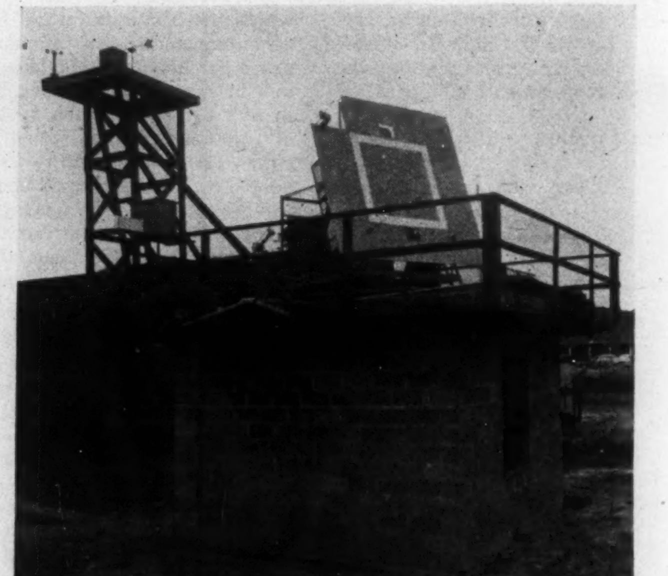
losses at suction hoods, and the other on air flow into suction openings. These studies formed part of a program carried on with the cooperation of the U. S. Public Health Service. This important field is very much before the Committee on Research, and a new Technical Advisory Committee on Industrial Ventilation has just been set up under the chairmanship of W. N. Witheridge. It contains many engineers well-known in the field. Some time ago we were reminded by a group meeting at the Laboratory that the word *ventilating* formed part of the Society's name. They asked that more attention be paid to ventilation problems. The work in the past twelve months and that planned for the future, will, we hope, convince those interested in ventilation that the subject is not being overlooked.

Heat Flow and Heat Transfer: Some of the most important studies that have been undertaken by the Society are currently under way in the Laboratory on problems of Heat Flow and Heat Transfer. Foremost of these perhaps are the studies on solar radiation transmission through glass. A British engineer visiting the Laboratory recently said that many people had talked about solar radiation transmission for many years, but so far as he knew this was the first time that anyone had really attempted to measure it in a manner likely to yield results of value to the heating and air conditioning engineer. The interest taken in these studies and the support given by certain sections of the industry are very encouraging.

Heat Transmission Through Glass: G. V. Parmelee, who is in charge of this work, first made a critical review and analysis of published information on heat transmission through windows and glass panels. His report is now being prepared for publication in the form of Research Bulletins. We believe it will be of real value to many members of the Society.

In line with recommendations made in the report, experimental measurements are being made of the solar radiation transmission through the various types of glass and glass elements in general use in building construction. A special piece of equipment, capable of holding a four-foot square pane of glass and orienting it in any desired fashion, was designed and constructed at the Laboratory and is now in use. We have also been studying the problem of radiation exchange between the glass and its surroundings. This is more commonly and less correctly called *night sky radiation* and is of importance in both steady state and periodic heat flow calculations.



Apparatus for measurement of solar radiation transmission mounted on roof of specially built test house

Film Coefficients: Another investigation resulting from the analytical survey was the experimental determination of forced convection heat transfer coefficients from smooth flat surfaces.[1] One paper has already been published, and a report on another phase will be presented at this meeting. These studies are, we believe, producing more accurate data than have been available hitherto. The results should reduce the errors or remove the *guesstimates* that have been a part of both heating load and cooling load calculations.

Periodic Heat Flow: The mathematical analyses of periodic heat flow through walls and roofs carried on by Prof. C. O. Mackey and his colleagues at Cornell University, Ithaca, N. Y., have brought us nearer our goal of providing accurate and easily usable design tables for use in load calculations. Professor Mackey pointed out in his reports that more accurate data on the thermo-physical properties of building materials were an essential step in the continuation of these studies. H. B. Nottage of the Laboratory staff has compiled such information[2] and will report on it at this meeting. He is also continuing with these studies to produce improved design tables suitable for use in The Guide.

Heat Transfer of Refrigerants: The investigation of the refrigerant-side film coefficients in a continuous-tube evaporator has been a long-term project at Case Institute of Technology under a cooperative agreement with the Society. One of the difficulties encountered was caused by the deviation of the thermal properties of the refrigerant from the published values. Some little time ago we were told that this was a $500,000 project. A report will be available this fall and, since we have been able to provide Case Institute with only about $1,000 a year, you will not expect them to have solved the whole problem. They are making an important contribution to the sum of our knowledge on this subject. In view of the tremendous increase in the application of refrigeration to air conditioning, such studies are of considerable importance to the whole refrigeration field.

Insulation Values

The secretary has said that The Guide chapter on Heat Transmission Coefficients of Building Materials is reprinted more than any other chapter. In view of this, it is important that the values given should be accurate. Some time ago, the Technical Advisory Committee on Insulation recommended that a program be initiated by means of which all commonly used insulating materials could be tested under standardized and identical test conditions. Twenty laboratories are now cooperating with the Society in this program. All have equipment which conforms to the latest standards developed by the Joint (ASHVE, *ASTM*, *ASRE* and *NRC*) Committee on Standard Method of Test for Thermal Conductivity of Materials by Means of the Guarded Hot Plate, and all have been supplied with identical samples of cork board. The experimental results are being analyzed by the Technical Advisory Committee on Insulation. The samples after test are returned to the Laboratory and forwarded to the

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[1] Heat Transfer by Forced Convection Along a Smooth Flat Surface, by G. V. Parmelee and R. G. Huebscher. (ASHVE Journal Section, *Heating, Piping & Air Conditioning*, August, 1947, p. 115.)

[2] Thermal Properties of Building Materials, by H. B. Nottage (to be published in ASHVE Journal Section, *Heating, Piping & Air Conditioning*).

Bureau of Standards which is cooperating with the Society in this program. The results obtained in the cooperating laboratories are checked against the results on the same sample obtained at the Bureau of Standards. The intention is to accredit those laboratories which are capable of obtaining satisfactory test results, and to have all accepted values for insulating materials result from tests carried out under standard conditions in an accredited laboratory. This is a somewhat different type of research program than the others mentioned. Its importance to almost every heating engineer, and certainly every design engineer, cannot be overemphasized. Accurate and dependable values of heat transfer coefficients established under standard and uniform conditions would be available for use in THE GUIDE and would be of assistance to every one.

Environment and Comfort: Three papers presented at this meeting deal with human reactions to environmental conditions; two of them directly as a result of Society sponsored work. Another is from the pen of the chairman of the Technical Advisory Committee on Sensations of Comfort,[3] who was one of our earliest and most highly respected investigators at the Laboratory. To round out the picture another well-known author will discuss *discomfort* at this meeting.

These papers bring before us some rather important questions which your Committee on Research will be called upon to answer. The Committee is therefore anxious to have your comments and to hear the views of practicing engineers as to the real value, after some 20 years of experience, of the comfort standards developed by early Society work. This work was done by a small group of very enthusiastic men at a time when little was known on the subject. This Society is known all over the world for its pioneer work in the development of the Effective Temperature concept. As our knowledge of these matters has increased, this concept and its application have been questioned. The time has come when we should re-examine some of these factors in the light of all that has been learned by the necessities of war. With your support, we plan to continue our investigations until we understand more fully what factors influence comfort and discomfort, and perhaps health and well-being.

Radiant (Panel) Heating: It is perhaps unnecessary to remind you of the pioneer work carried on at the University of California to develop fundamental data for the design of radiant (panel) heating systems. Although a number of technical papers have been published and design manuals and books made available, many heating engineers still find themselves somewhat confused in the design of such systems. The Society has been asked time and again for assistance in the development of design procedures. Unfortunately, with the exception of the work previously mentioned, there are very few fundamental experimental data available. Many feel that the present situation leaves much to be desired.

The Society has been in the forefront in the development of fundamental data for what are now the commonly accepted and used forms of heating systems. To retain that leadership, active work in the field of panel heating is essential. Those who have attended any of the recent Annual Meetings of the Society will have noted the great interest whenever this subject is on the program. The discussion at the 1947 Annual Meeting was further striking evidence of this interest. The challenge was made that the Society, through its Committee on Research, take positive steps toward a simplification of design methods and that the Committee make an experimental investigation of some of the more important physical and physiological factors involved in heating by low-temperature radiation. Last March a conference was held at the Laboratory attended by over 100 persons representing organizations interested in this field. There was full and frank discussion on many points, and as one might expect, some serious differences of opinion. A Technical Advisory Committee on Panel Heating is now being set up under the chairmanship of G. D. Winans, Detroit, Mich., with John James, Cleveland, Ohio, as vice chairman. The Committee will have a large program, but we feel sure that the results of its deliberations and the work which it sponsors will yield much of value to the members of the Society.

In Cleveland during the past winter we made some preliminary field explorations in homes using floor panels. We did not find any of the occupants registering ideally comfortable at a dry bulb temperature of 70 F or below. Most rooms showed air temperatures nearer 75 F, measured at the breathing level. We plan to do more field work next winter, in cooperation with the *Heating, Piping and Air Conditioning Contractors National Association* so as to gather enough data to be able to analyze them without reservations.

A bibliography of published data on panel heating has been prepared and copies are available to anyone interested. C. M. Humphreys, senior engineer at the Laboratory, is at present critically reviewing all published literature that contains factual data.

At Kansas State College, Prof. Linn Helander is investigating the relationships between radiant heating and cooling and human comfort and well-being. The main purpose of these studies is an attempt to determine thresholds of comfort and correlate them with mean radiant temperatures for various distributions of panel surfaces and varying air temperatures. As a preliminary, an analytical study has been made of the emissivity of heated and unheated surfaces as a factor in the design of radiant heating systems.

In any studies on radiant heating there are serious problems of instrumentation to be solved before the work done in different laboratories and by different investigators can be compared directly. We are cooperating very closely with those who are working on this subject in foreign countries and are endeavoring to bring together their accumulated experience for the benefit of the members of the Society.

Air Cleaning: The problem of adequate air cleaning is one of great importance to the future of air conditioning; it has no less significance in many problems of industrial ventilation. Considerable dissatisfaction has been shown with the present status of the testing and rating of air cleaning devices. In the fall of last year a number of the prominent filter manufacturers joined in a cooperative effort with some of the large users of air cleaning devices to support a program of fundamental research at the Laboratory. We are encouraged by the cordial reception given to the engineer working on this problem, and are more than ever impressed with the need for work of this type. The ultimate aim, as presently envisaged, is the preparation of sound and acceptable codes for the testing and rating of air cleaning devices. We shall welcome any criticism and assistance from those interested in the problem.

Psychrometry: Moist air is the working tool of the air conditioning engineer, and sound psychrometric tables and charts are essential to his work. Society research in the past has led to the development of accurate psychrometric tables; Society sponsorship has resulted in the formation of a Joint International Committee on Psychrometric Data in which many agencies in the United States and a significant number abroad are cooperating. Simultaneously we have sponsored an investigation at the University of Toronto on the measurement of the dew-point of air water-vapor mixtures, and while the results to date are by no means conclusive, they are valuable and have pointed the way towards a better understanding of the problems of condensation and dew deposition. Last year the Laboratory prepared a review dealing with the accuracy of psychrometric instruments and their application.

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[3] A Method for Improving the Effective Temperature Index, by C. P. Yaglou (to be published in ASHVE JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Weather Design Data: Day by day we realize the increasing importance of accurate weather data and of the incidence and coincidence of dry-bulb and wet-bulb temperatures and wind velocities. The changing emphasis placed by the Weather Bureau on the type of data collected has led to demands for its more careful analysis to bring out the significance of factors, which, until a few years ago, were perhaps not fully realized. A vast amount of data has been made available to the Society through the Technical Advisory Committee on Weather Design. The analysis of these data and their compilation into easily usable tables is a task of no small proportions. It constitutes a very real challenge to the Society and one which your Committee on Research is attempting to meet.

Conclusion

As heating, ventilating and air conditioning progresses from an art to a science, more and more dependable data must be produced. *Rules of thumb* and *factors of ignorance* may be acceptable in an art; they have no place in a science. The Committee on Research is engaged in developing these data. The results of research appear in the papers presented at this and similar meetings and, translated into a usable form, in the pages of THE GUIDE.

The outstanding place which THE GUIDE holds in this and allied industries is proved by the fact that several thousand copies are sold each year in addition to those distributed to the membership. There is complete cooperation and liaison between the Guide Publication Committee and the Committee on Research.

To meet the challenge of today, both the Committee and the Laboratory staff need the assistance of the membership and the industry. We need your encouragement and support both in spirit and in kind. Research work is costly, and the funds provided from the membership dues, grants by Council from publications and from the Exposition are only sufficient to maintain a nucleus of experienced personnel and to operate the Laboratory. To carry the program on efficiently and at reasonable speed, additional financial support is essential. This support should not be considered on a charitable basis, but as a sound business investment. It would be quite impossible for any single business organization to obtain such information itself for anything like the amount it might invest in the program.

Cooperative action along these lines, to insure healthy growth, is as essential today as it was when the Laboratory was first founded. The Committee on Research presents the ASHVE research program as a challenge to this industry.

H. B. Nottage, Cleveland, Ohio presented his paper, illustrated by slides, on **Thermal Properties of Building Materials** (to be published in the JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

H. B. Nottage

The paper, **Heat Transfer by Forced Convection Along a Smooth Flat Surface,** by G. V. Parmelee, and R. G. Huebscher (published in this issue, see p. 115) was also presented by Mr. Nottage.

Vice President Stacey then called upon Prof. F. W. Hutchinson, Lafayette, Ind., who presented his paper by title on the **Influence of Gaseous Radiation in Panel Heating** (published in the November 1946 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

The technical session was adjourned at 12:00 noon.

Effect of Sudden Temperature and Humidity Change on Comfort

Second Session—Tuesday, June 3

Pres. B. M. Woods called the meeting to order at 9:30 a. m. and announced that the session would be devoted to papers relating to human comfort and physiological reactions. He then introduced Mr. Glickman who presented the paper, **Physiological Adjustments of Human Beings to Sudden Change in Environment,** by Nathaniel Glickman, Tohru Inouye, Stanley E. Telser, M.D., Robert W. Keeton, M.D., Ford K. Hick, M.D., and Maurice K. Fahnestock (published in the July 1947 JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Mr. Glickman gave the results of a study of (1) the rapidity and magnitude of the physiological adjustments made by the body on exposure to sudden changes in environmental temperature; (2) the effect of different relative humidities in altering the adjustments when passing from a hot to a comfortable environment, and (3) the effect of different relative humidities on various physiological measurements with the body in approximate equilibrium with the environment. He pointed out that tests were conducted on 5 healthy male medical students, 19 to 23 years of age, who remained in a comfortable environment for one hour before and after one or two hour exposure in a hot room.

Nathaniel Glickman

Discussions were presented as follows:

E. F. DUBOIS, M.D., New York, N. Y. (WRITTEN): The main point of this paper is that large differences in relative humidity have a slight but significant effect at 76 F dry bulb. In practice it would seem advisable for heating and ventilating engineers to determine whether it is more practicable to control the relative humidity or the dry bulb or the air movement in order to obtain better comfort. It must be remembered that these experiments are performed on young healthy males and that results might not apply to women or older subjects. The results seem to point to the necessity for more studies of surface temperature as an index of comfort.

It would be advisable to make an extensive survey of skin temperatures of rather large groups of people under actual working conditions.

The results of these and other studies sponsored by the ASHVE are of considerable importance to physiologists and they should be published from time to time in physiological journals.

J. D. HARDY, M. D., New York, N. Y. (WRITTEN): I have read over the paper by Glickman et al and have the following comments to make:

1. The work is a step forward in the right direction in that it is a study of changes that occur in the body in response to a changed thermal environment.

2. More care is given the matter of relative humidity all the way through from the cool to the warm environment.

3. Much more attention has been paid to skin temperature as the important organ of heat loss.

4. The conditions which were studied most carefully were those under equilibrium circumstances, that is, after an hour or more exposure to allow transient responses to disappear.

In keeping with the past excellent work of these writers, they are studying comfort from the verbal report of the sensations of the subjects. This is entirely correct and I feel there is no other way to approach the problem. However, as thermal sensations are related to *changes* in skin temperature rather than to the *level* of the skin temperature, I think much more attention should be focused on such changes as related to comfort. Yaglou has proposed the actual level of the skin temperature as a dependable index correlated, to a high degree, with comfort. I feel that a level skin temperature and rectal temperature indicate only that the body is in a temperature zone in which it can regulate physiologically. If, however, the skin temperature has to go through cyclic changes about a mean, such as we have observed in the sweating and shivering zones, strong sensations arise from the periphery and cause discomfort. I feel that we, as well as others, will probably find that comfort is the zone in which these changes are minimal.

AUTHORS' CLOSURE: Referring to Dr. Hardy's comments, when subjects are in equilibrium with the environment, the level of mean skin temperature is a good index of the degree of warmth experienced. However, when the environmental conditions are changed suddenly or the subject is not in equilibrium with the environment, the level of mean skin temperature is a poor index of the degree of warmth experienced. Under these latter conditions the change of mean skin temperature may give a better index, although this alone probably is not the best index.

We have been attempting to analyze our data to determine the relationship between sensations of warmth and change of mean skin temperature at different levels of mean skin temperature. As Dr. Hardy mentions, comfort is in the zone where these changes are minimal, but this does not obtain when the mean skin temperatures are above or below the range indicated for comfort. If the subject is in an environment which is above the comfort zone, then the end organs for the perception of heat are stimulated, although the changes in the mean skin temperature may be minimal. A similar condition with respect to cold sensations may exist in an environment below the zone of comfort.

We are in accord with the comments of Dr. Du Bois.

These experiments are now being repeated on older subjects, and it is planned to obtain similar experiments on women.

It would, indeed, be advisable to perform studies similar to those of Dr. Bedford on large groups of people under actual working conditions and attempt to correlate comfort with mean skin temperatures. Perhaps we shall be able to do this in the future.

Comfort as Absence of Discomfort

The second paper, **Conditions for Comfort**, by C. S. Leopold, Philadelphia, Pa., (published in the June 1947 JOURNAL SECTION, *Heating, Piping & Air Conditioning*) was presented by the author.

Mr. Leopold defined comfort as the absence of discomfort or annoyance due to temperature and atmospheric effects indoors. He stated that a thermostat setting of 75 F has been found to meet the summer and winter comfort requirements of occupants in a number of large office buildings where thermostats are set by either the occupant or by the custodian. With the 75 F setting, Mr. Leopold explained that the relative humidity is varied from approximately 30 per cent in winter to 50 per cent in summer. He presented a *discomfort* chart to facilitate evaluation of maintained conditions and made a distinction between optimum comfort for an individual and for a group.

C. S. Leopold

Discussions were presented as follows:

F. C. WOOD, York, Pa. (WRITTEN): The author, in my opinion makes sense, both as to the general theme and the conclusions he has drawn.

The striving for improvement in quality, stressed today possibly more than at any time in the past, is a highly commendable trend in the air conditioning art. Certainly this search for better air conditioning should not overlook what is probably the major factor affecting optimum comfort, or minimum discomfort — air temperature. I agree with the author that design should seek to produce the optimum in comfort and am of the opinion that today there appears to be little justification, economically or otherwise, for appreciable deviation from this objective.

The willingness to accept the *80 F and 50 per cent*, and warmer summer cooling design conditions in the past as comfort criteria has doubtlessly been motivated largely by the desire for more economical comfort conditions than are obtainable at the optimum, as established by ASHVE tests and indicated on the Comfort Chart. Also there has probably been the belief that *80 F and 50 per cent* or warmer was *cool enough*, and represented desirable comfort conditions.

Field practice often has not substantiated the latter contention. Many installations, particularly in office buildings, designed for these warmer conditions, were ultimately operated at, or close to, the ASHVE optimum with the thermostats set to produce conditions of 76 to 78 F or lower. This seemed to insure the least number of complaints of an *uncomfortably warm* origin, from the occupants, leading to the conclusion that the reactions of a large group of people, uninhibited by the knowledge that they were being tested and having the further advantage of numbers, nevertheless agreed with the ASHVE Laboratory tests. As the author brings out, such agreement between field reactions and laboratory tests provides a firm basis for design.

The degree of success obtained in maintaining these lower-than-design temperatures continuously in the office buildings referred to depended on such factors as available excess plant capacity, newness and condition of the equipment, building thermal lag, duration of outside peak temperatures, actual operating load factors, etc.

Therefore, it would seem to be good logic to design installations in anticipation of ultimate usage demands as to temperature conditions. The premium in additional cost to produce and maintain the optimum comfort temperatures should be small, percentage-wise, and there is ample evidence today that the public will pay for improvements of this type that reflect better quality in air conditioning. The attention and consideration being given to air cleaning and purification, odor elimination, radiant heating, better zoning and selective individual space temperature control, and other refinements, substantiate this, and further support the author's conclusion that, *there would appear to be little justification for an installation which appreciably compromises with optimum results as to comfort conditions.*

W. A. GRANT, Fayetteville, N. Y. (WRITTEN): Our industry has long needed the practical approach to the problem of optimum room conditions, which the author has so ably presented. There is no substitute for field proof of every kind of laboratory test, and in this instance the proof is in the *conditions that the occupants are using* day after day.

Many of us who have made observations over the years are completely non-plussed that so many people, including engineers and men of science, still labor under the delusion that 68 to 70 F room temperature is comfortable in the winter time. The cold facts of *what people use* simply do not bear out this preconception. While there is a band of acclimatization between summer and winter, it appears to be much smaller than the ASHVE data have led people to suppose, and it is time that the winter data in particular be most carefully reviewed. It may be that the newer 1941 data are more nearly correct for the northern part of this country, but my own observations indicate that they are definitely on the low side for the milder areas.

For summer design conditions, there seems to be less and less justification for continuing the commercial standard of *80 F and 50 per cent* as a basis of design for systems with continuous occupancy. It would be much more rational to design for a condition within the band the author has proposed, such as 76 or 77 F, which can be maintained during the normal peak summer weather. The slight penalty in additional first cost is unimportant if we take the position that the purpose of summer air conditioning is to make people comfortable rather than less uncomfortable.

This paper again raises the question *what is the importance of relative humidity in relation to comfort and health?* Outside of including it as one of the factors in the effective temperature index, the Society has shed no light on this important question, for either summer or winter. Practising engineers do not yet have any substantiation that winter humidification is a good thing, or that low humidities in summer are preferable to high humidities. Considering all the research that has been done on comfort, this is an embarrassing position to be in, and an organized attack on the problem is badly needed.

I think the Society is greatly indebted to Mr. Leopold for his clear-thinking, common-sense paper.

JOHN EVERETTS, Jr., San Francisco, Calif. (WRITTEN): The author has as usual attacked the problem from the right angle instead of the wrong angle.

For many years we have been trying to maintain and meet an ideal condition of comfort which, of course, has never been reached. The optimum condition of comfort is based upon evaluating the opinions of people who are asked *Are you comfortable?* This immediately raises the doubt in their minds as to whether they are or are not comfortable . . . they may be either a little warm or a little cool. However, if the same people were asked *do you feel any discomfort?* then the question would revert itself to the point where they may feel a little warm or a little cool but *not* necessarily discomfort.

I definitely feel that the comfort chart as set up by the Society is an excellent means of obtaining or attempting to obtain an ideal condition and should be used in all design work for comfort cooling. I think that the author might go a step farther on his discomfort curves and, instead of correlating the present comfort chart into a discomfort curve, actually determine or have determined from observations and public opinion exactly where the discomfort lines may appear. I am sure that we would find quite a divergence in thinking if the term *discomfort* were applied in place of the term *comfort.*

My highest compliments to the author on his usual logical thoughts and clear presentation of this subject.

The Importance of Humidity to Comfort

R. C. Jordan

Dr. Woods introduced Prof. R. C. Jordan, Minneapolis, Minn., who presented the paper, **Comfort Reactions of 275 Workers During Occupancy of Air Conditioned Offices,** by F. B. Rowley, R. C. Jordan, and W. E. Snyder (published in the June 1947 JOURNAL SECTION, *Heating Piping & Air Conditioning*).

Professor Jordan gave the results of a study of the general reactions of 275 employees during working hours and indicated that the conclusions refer to only a particular office and a group of employees and may not be applicable to other groups.

The maximum number of persons indicating comfort occurred at a dry bulb temperature of 74 F and variations of relative humidity between 35 and 60 per cent caused no change in the feeling of comfort, as pointed out by Professor Jordan.

The lack of humidity effect on feeling of warmth, he stated, is ascribed partly to inherent limitations of the effective temperature index and partly to the many factors which enter into an individual's feeling of warmth. Professor Jordan explained that these factors could be controlled in laboratory tests but not in the test in a business office.

Written discussions which were presented follow:

F. C. MCINTOSH, Pittsburgh, Pa. (WRITTEN): Although the data presented by the authors are too few to justify final answers, there seem to be enough to indicate definite disagreement with our Comfort Chart.

I have a special interest in this subject. About three years ago, I started preparing a paper for the Society on the merits of controlling indoor temperatures higher in cold weather than in moderate weather. This applied to the heating season. The greatest of three factors was the humidity effect shown in our Comfort Chart. In the Pittsburgh district, this indicated that the dry bulb temperatures should be varied over a range of about 4 deg, as the relative humidity changed between 25 and 70 per cent.

In order to have more material for the paper, I arranged for field tests in three buildings having a total of about 40 rooms under control. Thermostats were set for automatic temperature increase in colder weather (by humidity effect). In a short time I found that something was wrong with the calculations because complaints of being too warm came in dry rooms. Eventually the correction was reduced to one half the initial amount, and it is my opinion that this correction is taking care of the factors, other than humidity, which were included in the calculation. This experience may have been due to the negligible importance of relative humidity in the winter comfort zone.

At the same time I started reading and inquiring on the subject. Dr. C.-E. A. Winslow had evidence that disagreed with the Comfort Chart. Prof. C. P. Yaglou, who worked on the original Society project,[4] no longer accepted those findings. Even THE GUIDE has referred to other studies indicating that the Comfort Chart may not show the true effect of relative humidities.

The Society has used this chart for nearly 25 years with no changes, and criticism of it seems to have been treated as heretical. In my opinion we owe the authors a vote of thanks for presenting their conclusions so clearly and we should follow the recommendation they have made.

C. S. LEOPOLD, Philadelphia, Pa. (WRITTEN): The report as originally submitted contained a number of graphs which are not included in the final report. In this discussion it is necessary to make some reference to these findings.

According to the present effective temperature lines, the entire variation from 35 to 60 per cent RH (relative humidity) is approximately 3 F deg dry bulb. The general effect of relative humidity is accepted by practically all serious investigators and the question is only one of the degree of this effect. Since the analysis here presented showed an actual reverse in the effect of relative humidity, it is advisable that we check the experimental procedure to see if these inconsistent effects could be due to a systematic error in procedure.

According to the original report[5], the range of acclimatization over the period of the test was from 69 to 74 ET (effective temperature) which, at constant humidity, is approximately 5 deg dry bulb. Since, for the present report, results for the entire period were considered, any systematic error introduced by acclimatization is also included and a small systematic error in an 8 deg effect would vitiate conclusions drawn as to a change in a 3 deg effect. To check within 3 deg dry bulb would require an experimental set-up capable of an accuracy of less than 3 deg.

Such accuracy implies the complete elimination of all variables except those being investigated and a mathematically adequate distribution of maintained conditions. There is some evidence that the test did comply with these qualifications.

Although this is the fourth report based on these experiments, the log of daily operating conditions has not been made available. It is, therefore, necessary to deduce a portion of the experimental background from the previously published paper.

Test Procedure: From the earlier report[6] we learn that three sets of apparatus were used to supply the test area. All apparatus utilized 52 F well water for dehumidification and cooling. Apparatus No. 1 employed an air washer and the other two utilized *dry* coils.

1. In order to maintain satisfactory dew points, the average commercial job requires water approximately 6 deg. cooler than the well water used in the experiments.

2. If reheat were not used in warm and hot weather, as has been verbally reported, the ability to maintain relatively low humidities would be further affected.

3. Since the operating log is not available, it is necessary to refer to the log sheets for individuals (included in the full report). Collectively they indicate that there were few tests made at humidities below 45 per cent.

4. Inspection of the data for conditions maintained for person G, a. m. and p. m. separately recorded, indicates that in general the afternoon conditions were warmer and drier, with higher effective temperatures, than the morning.

5. A condition reported as *warm* by an individual acclimated to 69 F could be reported as *cool* to the same individual acclimated to 73 F, and this error could only be eliminated if there were an even distribution of observations for each combination of relative humidity and dry bulb for each effective temperature to which the subjects became acclimated over the period of the tests. If, as appears from the data, high indoor humidities tended to accompany high outdoor temperatures, and low indoor humidities tended to accompany low outdoor temperatures, the error would be of sufficient magnitude to nullify the conclusions.

As a result of the limitations in the means of dehumidification (1 and 2), cool conditions could only be obtained in warm weather by producing high humidities and low temperature. Similarly, low humidities could only be obtained when the outside dewpoint was low, particularly for Apparatus No. 1.

Inspection of the graphs for individuals (3, 4, and 5) presents additional evidence that the distribution of conditions maintained was inadequate for a statistical analysis.

Actual Test Results: It is not necessary to assume an error in the effective temperature lines in order to explain the results actually obtained. The original report[7] states:

> For the data collected up to and including July 31st, the several zones conditioned by the different systems were all operated with the view to giving maximum comfort without reference to the study.
>
> For the period August 1 to September 30, occupants in the different zones, or at different times within the same zone, were given a range of effective temperatures designed to give a greater spread when plotted as in Fig. 2. The variations in effective temperature for optimum comfort for this latter period in the summer are therefore somewhat more significant than for the earlier period.

For the period May through July, we would expect a relatively constant line for *ideal*, as shown in Fig. 7, as this was exactly the condition the operators were trying to produce and they would, therefore, be expected to take into account acclimatization. Because of the test procedure, it would appear that as a minimum the analysis should deal separately with the tests before and after July 31st.

The graphs for constant temperatures indicate, in many cases, that increased relative humidity increased the votes for *cool*, which is not only at variance with the effective temperature lines but is even at variance with those investigators who question the degree to which an increase in relative humidity tends to increase the feeling of warmth. The results, however, can be readily explained by realizing that with the subject apparatus, and in hot weather, moderate or low effective temperatures could be obtained only by the combination of low dry bulb and high humidity.

Consideration of this limitation on the production of test conditions, together with the effect of acclimatization, would indicate that Fig. 5 is the reasonable outcome of the experimental procedure, even if the effective temperature lines are correct to the minutest detail.

Were the experimental data valid, we could conclude that 35 to 40 per cent RH would satisfy more people

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[4] Determination of the Comfort Zone by F. C. Houghten and C. P. Yaglou, (ASHVE TRANSACTIONS, Vol. 29, 1923, p. 361.)

[5] RESEARCH REPORT No. 1088—Summer Cooling Requirements of 275 Workers in an Air Conditioned Office, by A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley. (ASHVE TRANSACTIONS, Vol. 44, 1938, p. 337.)

[6] Loc. cit. see note 5.

[7] Loc. cit. see note 5.

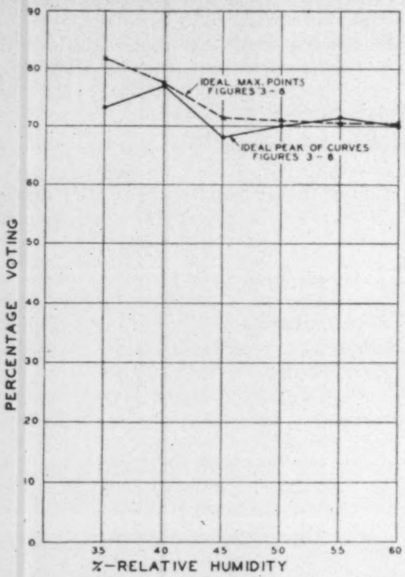

Fig. A—"Ideal" vote based on Figs. 3 to 8

than any other. This is shown in Fig. A (which I herewith submit and immediately disown as a generality) where the dots illustrate points selected as the peak of the smooth curves and X equals the highest points for Figs. 3 to 8. For the smooth curve there is a peak in *ideal* at 40 per cent with a drop at 45 per cent then a partial recovery. For points, the maximum is at 35 per cent with a sharp drop at 45 per cent. As generalizations, both results appear improbable and the error probably rests in peculiarities of the installation or its operation. For example, at humidities of approximately 45 per cent and below, well water could not be used in the air washer of Apparatus No. 1 if it were desired to produce low effective temperatures without unduly increasing humidity and the points of use or non-use would introduce a variable. Apparently this system performed better when not called upon for dehumidification.

Referring again to the original report[8], Fig. 7, we obtain the results shown in Table A.

Table A—Comfort Temperatures

All Men and Women	Optimum ET	Ideal Maximum per cent
May 20 to June 10	69	57
July	71.5	55
August	70.	75
September	68 5	67

These results are significant in that the percentage of people satisfied is considerably lower than that reported in similar tests in other cities and this is particularly true of the period May 20 to June 10 and for the month of July, at a time when the operators were trying to produce maximum comfort.

Assuming the adequacy of the method of sampling opinion, these results would indicate limitations of the apparatus or its operation. In the absence of the operating log, we have no means of telling what index the operators used to establish comfort and whether or not they were trying to follow the outdoor temperature.

In order to be able to draw any conclusions on the effect of relative humidity, it would be necessary to break down the data as, for example, on the basis of a day or less or, at the most, on the middle portion of a hot or cool spell, avoiding the first day. Interesting information might also be obtained by separately analyzing the areas served by Apparatus No. 1 as compared with Nos. 2 and 3.

Conclusion: In view of the foregoing, I hope that the authors agree that their report should be critically re-examined because, unless my comments on acclimatization and the distribution of observed conditions are invalid, there is no basis for drawing any conclusion as to the effect of relative humidity on effective temperature.

The authors suggest that the lack of any humidity effect on the feeling of warmth might be due to factors entering into an individual's feeling of warmth, which could be controlled in a laboratory but not in a business office. I believe that the real difficulty was not due to the particular group of people or the physical arrangement of the office but was largely due to the lack of flexibility of the apparatus to provide conditions to cover a full range, as required for a test of this type. In other words, the experimental procedure does not justify the statistical analysis.

I agree with the authors' recommendation of further tests on effective temperature. Before undertaking these tests, however, I think a critical review of previous work is in order and that the first experimental work should be devoted to the re-establishment of the winter optimum effective temperature line, which has been shown by the later work of the Laboratory to be at important practical variance with the 1923 experiments. It is further suggested that in conducting these tests the Laboratory equip its apparatus with electrostatic filters and charcoal adsorbers in order to minimize the odor effects which frequently accompany high humidities.

R. S. L. **Arnold**, Philadelphia, Pa., (**Written**): The conclusions drawn by the authors undoubtedly indicate that more investigation along this line should be made. Before we discount too much the reliability of applying the effective temperature chart to air conditioning installations, it would certainly seem that other studies should be made taking into consideration a number of factors which have not been mentioned in this paper. It is noted that no mention has been made regarding the conditions of air motion under which these tests were made. Air motion, as well as air distribution, has a profound effect on sensations of comfort.

Furthermore, radiant heating and radiant cooling have considerable effect on comfort and this factor should be taken into consideration. It is well recognized that occupants of a room who are located near an exposed wall would experience a large amount of radiation effect on severe days whereas in this same room the occupants near inside walls would experience very little effect from radiation.

Other factors enter into a person's feeling of comfort, such as rate of metabolism and state of mind at the time when subjected to a certain condition of atmosphere within the space occupied.

No doubt this study has a great deal of merit but more investigation should be made before stating too definite a conclusion regarding the reliability of the effective temperature chart.

John Everetts, Jr.

The final paper of the session, **A Method for Improving the Effective Temperature Index**, by C. P. Yaglou, Boston, Mass., was presented by John Everetts, Jr., (paper together with discussions to be published later in the JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

In presenting the paper, Mr. Everetts pointed out that although recent studies in body heat regulation have not developed a more practical thermal index than effective temperature (ET) much fundamental information has been contributed that can be used to correct the ET index for humidity and radiation.

The meeting was adjourned at 12:00 noon.

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[8] Loc. cit. see note 5.

F. W. Hutchinson

Third Session—Wednesday, June 4, 9:30 a. m.

The technical session was called to order at 9:30 a. m. by President Woods. The first paper, **Experimental Studies on Panel Heating Tube Spacing,** by B. F. Raber and F. W. Hutchinson, was presented in brief by Professor Hutchinson, (published in this issue, see p. 111).

Professor Hutchinson stated that conductance of nine 4x4 ft test panels (hot water type) was determined for 3/8, 1/2 and 3/4 in. of copper tubing spaced on 4, 6 and 9 in. centers. Based on 6 in. spacing as 100 per cent, the panel conductance for 9 in. and 4 in. spacing, he pointed out, was reduced to 72 per cent and was raised to 154 per cent respectively for the three sizes of tubing used in tests.

Triethylene Glycol Vapor Distribution for Air Sterilization

President Woods then requested L. P. Saunders, Lockport, N. Y., Chairman of the ASHVE Committee on Research, to take charge of the meeting. Mr. Saunders presented Prof. B. H. Jennings, Evanston, Ill., who gave the paper, **Triethylene Glycol Vapor Distribution for Air Sterilization,** by Edward Bigg, M.D., B. H. Jennings, and F. C. W. Olson, (published in the May 1947, JOURNAL SECTION, *Heating, Piping & Air Conditioning*).

Professor Jennings described apparatus for production and duct distribution of triethylene glycol vapor for air disinfection in a large building. He stated that uniformly spaced molded ceramic fittings on 9 ft centers delivered glycolized air from the ducts, in which the mixture was carried at relatively high static pressure, into the upper portion of the rooms with satisfactory results.

He illustrated by slides how individual units for delivering triethylene glycol vapor were used in barracks where experiments were conducted to determine effect of the vapor on incidence of respiratory infection. He also stated that a reduction of 46.2 per cent in disease incidence was found to result from the use of the triethylene glycol vapor in sleeping quarters.

Discussions were received as follows:

B. H. Jennings

L. J. BUTTOLPH, Cleveland, Ohio (WRITTEN): The effectiveness of this installation in which glycol vapor was introduced relatively near the ceilings and from rather widely spaced fittings to secure a good distribution of vapor throughout the whole volume of the rooms, with a relatively small volume of air and air movement used to introduce the vapor, and with no mechanical air circulators in the rooms, seems to confirm observations of those who have studied the effectiveness of upper air ultraviolet irradiation in reducing the bacterial content throughout the lower air of a room. In both cases the practical results seem hard to interpret other than on the basis of a random air circulation throughout the whole room, considerably greater than is ordinarily visualized by ventilating engineers.

It would be interesting, if possible, to determine whether glycol vapor is distributed and maintained throughout the whole volume of such experimental rooms at concentrations continually effective *at the time and place of contamination*, or whether the germicidal action takes place largely in the upper air where the glycol concentrations are presumably considerably greater, with a lower air effect resulting from air circulation and dilution.

Although the opinion does not appear in this paper, advocates of both glycol and of ultraviolet air disinfection have sometimes maintained that rates of air decontamination sufficiently rapid to reduce the spread of respiratory diseases are impractical of attainment by ventilating dilution with fresh air. How practical natural ventilation may be for this purpose is obviously a function of the cost of heating and moving the required air. Perhaps this aspect of the problem of air disinfection or decontamination should be examined more closely.

Innumerable additional excellent studies such as this of the epidemiological value of air disinfection will probably be needed before there can be any final appraisal of its value. In the meantime the value of individual studies could be increased very greatly if there were some common criterion of air disinfection such as either the per cent or the absolute reduction in index organisms, to correlate the epidemiological results secured by the three obvious methods of air disinfection. To what extent may we assume that the epidemiological results of air disinfection are independent of the method of disinfection?

W. T. ANDERSON, JR., Newark, N. J. (WRITTEN): The Commission on Airborne Infections, Army Epidemiological Board, *American Journal of Public Health*, Dust and Its Controls as a Means of Disinfection of Air, Vol. 37, p. 353, 1947, has reported that dust in army barracks becomes highly contaminated with certain pathogens associated with certain diseases of the respiratory tract, particularly those which may cause streptococci infections. These micro-organisms are dispersed into the air from bedclothes, floors, and clothing at times of floor sweeping, bedmaking, and dressing, and provide opportunities for the spread of disease by direct or indirect contact with the infected dust. Oiling of floors, bedclothes, and other textiles proved highly effective procedure for the control of dust-borne bacteria. The action is only a mechanical one. Studies have indicated that this oiling process can result in a very significant reduction in infections of streptococci origin. They concluded that its combination with glycol vapors, or ultraviolet, or adequate ventilation offered the best opportunity to control air-borne bacteria.

It appears unfortunate to the writer that in the present experiments with glycol vapors some attention was not paid to the effect of oiling of floors. If both the floors of the control and the glycol treated rooms had been oiled, would the differences in reduction of infection between the two groups have been so great? How much of the effect was due to glycol on the floor acting as an oil to hold the dust? How much was due to the glycol actually removing air-borne bacteria? In other words, can nearly the same results be obtained if the floors are swabbed with glycol liquid?

It is quite possible that the authors have the answers to my questions. If they do, I would appreciate greatly having literature references if the answers have been published. Unfortunately I do not have the answers, but the report of the Commission cited in the first paragraph is suggestive.

Attention is also directed to a paper entitled Recent Studies on Disinfection of Air in Military Establishments, *American Journal of Public Health*, Vol. 37, p. 189, February, 1947, which states that *The use of triethylene glycol must be supplemented with dust control measures if it is to be successful.*

W. F. **Wells**, Philadelphia, Pa. (**Written**): By recognizing the significance of engineering design and operating efficiently in the environmental control of air-borne contagion, the authors have taken an important step in the development of chemical disinfection of air. A recent report from the *American Public Health Association* grants that air disinfection is indicated under particular conditions in hospitals, but pronounces general application at the present time and indiscriminate use at any time as unjustifiable. The ventilating engineer and the sanitarian are therefore charged with the responsibility of specifying the conditions and circumstances of sanitary ventilation.

An ASHVE Technical Advisory Committee on Air Sterilization has been appointed by the Society to study the problem of sanitary ventilation and to present recommendations for a new chapter in The Guide on this new ventilating art. The paper here presented will help much in defining the field of application of glycol vapors in air disinfection.

Perhaps some means of testing the efficiency of installations is the most pressing need of the ventilating engineer and the public health official. We atomized constant numbers of standard test organisms into ventilated spaces and determined by the air centrifuge the equilibrium concentration with and without air disinfection. This gave a measure of the sanitary equivalent in terms of air changes which would remove equal numbers of pathogenic organisms tested in the laboratory.

The isolation and identification of organisms contributed by occupants gives another method of measuring ventilation load; streptococci of the nose and throat can usually be isolated during the winter from five cubic foot samples of occupied atmospheres.

Ultimately these values should, as the authors say, be correlated with epidemiologic experience, though it may take as many years as it took to establish quality standards of drinking water supplies.

H. C. **Murphy**, Berkeley, Calif. (**Written**): I have been much interested in the very excellent paper presented by Professor Jennings and would like to submit my comments. In Fig. 2 the authors show an *inlet silencer* and then state:

> This muffler shown in Fig. 2, consisted of a three foot length of six inch diameter duct. Forty-eight one inch holes were cut in the side of the duct; a heavy screen was fixed inside the duct six inches from the fan; and steel wool was packed loosely in the duct. The noise reduction by this method was sufficient in all cases where the blowers were installed in corridors. One blower was installed in a classroom and required a special soundproof box. This box was built of sheet metal and lined with one inch hair felt. Excellent silencing was obtained by this method.

In effect I believe this muffler is a fairly efficient air filter of the viscous impingement type. The loosely packed steel wool with the glycol coating picked up from the recirculated air would, I believe, have a measurable efficiency in removing air-borne organisms.

Dalla Valle and Hollaender of the U. S. Public Health Service indicate in Vol. 54 No. 17 of the *U. S. Public Health Reports* dated April 28, 1939—that steel wool filters three inches thick were found in their investigations to have efficiencies of 83 to 85 per cent in removing a test organism (the B. subtiles) from an air stream.

Lemon, Wise and Hamburger in the August 1944 issue of *War Medicine* Vol. 6 pp. 92-101 discuss their studies of the bacterial content of air in Army barracks. Their investigations covered the use of viscous impingement filters 2 in. thick and their studies established efficiencies as high as 94 per cent in some cases for these units in the removable of air-borne bacteria. In their conclusions they state:

> The chief factor in the reduction of the bacterial content of air passing through the heating unit is the air filtration system. Dry or oiled wire mesh filters seem to possess about equal efficiency in removing air-borne bacteria. Filters partially clogged with dust and lint are somewhat more effective than clean ones, but if too dirty they interfere with adequate air circulation. There is some evidence that settling out of bacterial particles in the plenum chamber of the furnace further reduced the number of air-borne bacteria. Neither furnace heat nor the centrifugal action of the blower appears to have any influence on the number of recirculated bacteria.

W. L. **Holladay**, Los Angeles, Calif. (**Written**): In the controlled test of sleeping quarters, was any effort made to simulate a test in the untreated area? For example, were dummy vaporizers holding plain water installed in the untreated zone, so the two zones would look alike to the occupants, and the psychological factors in each zone would be equalized? If such a precaution were not exercised, there may be a possibility that some of the cases from the untreated zone were psychosomatic in character.

Authors' Closure: The authors appreciate the comments which have been made in the written discussions and in those which were orally presented at the meeting.

We are very much in agreement with Dr. Wells that some method of measuring the effectiveness of air disinfection be prepared. These standards would be of great help in making comparative analysis of the effectiveness of different methods of air purification control. The measure of *sanitary equivalent* which we used was a chemical analysis of the air to determine the amount of glycol present. Laboratory standards for effective bactericidal concentrations of glycol have been well established and our standard for effectiveness was based on these data. It was our feeling that since these concentrations were reached, we were obtaining effective bactericidal levels.

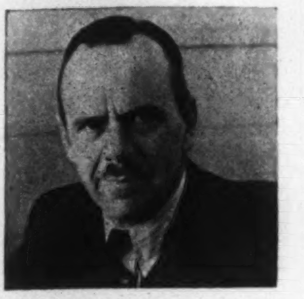
In reply to Dr. Anderson's comment regarding oiling, it should be mentioned that blankets and floors in the barracks were treated according to the standards established by the Commission on Air-Borne Infections. This procedure was applied in both test and control spaces. From a study of the literature available at this time, it would appear that the effectiveness of dust control measures alone in controlling air-borne disease has not been established. Our results confirm this observation.

Mr. Holladay questioned the psychological factors present in our test. We would like to stress the fact that our disease incidence was based only upon those cases admitted to the hospital for diagnoses and treatment. The severity of these infections and the bacteriologic evidence collected was such as to place them beyond the possibility of being psychosomatic in nature.

Mr. Buttolph brings out the same point as Dr. Wells does in regard to the need for standards of measuring the effectiveness of air disinfection. Mr. Buttolph's point as to where, in a given space, the disinfection takes place, is also quite pertinent. Our measurements for glycol concentration in the treated space were made at the lower level in the room in the breathing zone, and previous observations have shown that the concentrations indicated are bactericidal. It is quite possible that conditions could exist in a space where, through lack of diffusion or dissemination, parts of the room had glycol in sufficient concentrations to be bactericidal.

In reply to Mr. Murphy, it should first be mentioned that the epidemiological statistical data mentioned in this paper were obtained in the barracks and not in the space where the muffler and duct system were employed. Our paper in this connection demonstrated that glycol could be distributed through a space by means of an individual duct system. There is certainly no question that filters could remove from a system a large portion of the bacteria suspended on large particles.

Outside Design Temperatures



W. L. Holladay

The next paper, **Determination of Outside Design Temperatures,** by W. L. Holladay, Los Angeles, Calif., (published in the July 1947 JOURNAL SECTION, *Heating, Piping & Air Conditioning*) was presented by the author.

The author suggested a method of using present available Weather Bureau temperature records for establishing outside design temperatures for summer and winter. He included nomographs for determining (1) winter design temperatures from the average minimum and lowest temperatures, and (2) summer design temperatures from average maximum temperature and highest temperature.

The following discussions were presented:

JOHN EVERETTS, JR., San Francisco, Calif. (WRITTEN): I believe that the author's suggestion of a nomograph is good. It tends toward a simplified approach to determining design conditions for cities which have Class B and Class C weather stations where only maximum and average conditions are given. I think that this should be given further study by the Technical Advisory Committee on Weather Design Conditions to see if this can be applied universally.

I would like to bring to the author's attention that in Table 4, Column H shows maximum temperatures worked up by Albright and Everetts for the Marley Co. book entitled *Weather Design Data.* Column G, attributed to Marley, is actually the design temperatures taken from this same book and use of this eliminated Column H from Table 4.

It is also recommended that wherever design dry bulb and wet bulb conditions are given, a design dew point should also be given. This design dew point is, of course, *not* the coincident dew point for the design dry bulb and wet bulb conditions. For example, in Table 5 San Francisco's design dry bulb is 85 F and design wet bulb is 65 F giving the coincident dew point of 53 F or 60 grains of moisture per pound. The actual design dew point for San Francisco is 64 F at the airport or 90 grains per pound. Therefore, if dehumidification is to be designed for these conditions and the final moisture content reduced to 40 grains per pound, it is noted that the coincident dew point of this table will only be a reduction of 20 grains per pound whereas the actual duty necessary for this area would be 50 grains removal or 2½ times as much. The same applies to Portland, Ore. where Table 5 gives a design dry bulb of 90 F and wet bulb of 66—giving the coincident dew point of 52 F or only 57 grains of moisture per pound. The actual design dew point for Portland is 90 grains per pound.

I do not agree with the author that in Table 5 the summer design dry bulb should be taken in steps of 5 deg. With an inside design temperature of 80 F and an outside design temperature of 90 F, this is a spread of only 10 deg. If the outside design temperature should be 92½ or 93 F, it means that the cooling load would be off 25 per cent in transmission load, 25 per cent in sensible heat in the ventilating load, and 25 per cent in the solar heat load where temperature difference and a solar heat factor is used. As far as winter design is concerned, this makes very little difference because there we are talking about conditions from roughly plus 20 to 70—a spread of 50 deg. A 2½ deg plus or minus will make very little difference. I believe that the design dry bulb for cooling should be kept within the range of one degree.

AUTHOR'S CLOSURE: I am very appreciative of Mr. Everetts' suggestions on coincident dew point. It is unfortunate that this dry bulb study was made to determine shade temperature differentials for heat flow, and that the use of wet bulb figures from other sources results in an incorrect calculation of latent heat removal from make-up air. My discussions with Mr. Everetts have brought up the suggestion that future published tables might include a dry bulb design temperature for heat flow calculations and a *dew point design temperature* for latent heat calculations, eliminating entirely the wet bulb temperature, which must be considered in conjunction with a dry bulb figure for the determination of moisture content in outside air. The determination of these dew point design temperatures looks like another job for the Technical Advisory Committee; it is hoped that some consistent means may be developed for recommending the temperatures to be used.

Mr. Everetts' recommendation for expressing summer dry bulb temperatures in units of one degree is possibly debatable. His example is of course correct, but it is also true that the transmission load is a small part of the total cooling load (in a number of our jobs picked at random, normal transmission averaged about 30 per cent of total). It is questionable whether, in the average cooling calculation, the accuracy is of such high order that normal transmission needs to be figured to one degree. If it is necessary, the nomograph (Fig. 2) may be used instead of Table 5.

The author is grateful to Messrs. Everetts and Tasker for their valuable criticism.

Predetermining Heat Flow Paths in Building Structures

C. F. Kayan

The final paper of the session, **The Effect of Floor Slab on Building Structure Temperatures and Heat Flow,** by Prof. C. F. Kayan, New York, N. Y. (published in the June 1947 JOURNAL SECTION, *Heating, Piping & Air Conditioning*) was presented by the author.

With the aid of slides Professor Kayan showed the complex heat flow paths to be found in building structures in a wide variety of forms and arrangement. Under such circumstances it is difficult, and generally impractical, he stated, to calculate steady-state heat flow and surface temperature distributions by orthodox mathematical or graphical techniques, particularly when surface conductances are involved on the high and low temperature sides. He presented isotherms for different cases of building structure heat flow and described the apparatus and an experimental method for predetermining heat flow by means of electrical analogy.

Discussions were presented as follows:

John Everetts, Jr., San Francisco, Calif. (Written): I would like to compliment the author on the presentation and the analysis of a subject about which very little work has been done. This is, of course, a preliminary study of a subject which is important to anyone in the heating, air conditioning and refrigeration field.

Recently, I have been making a similar study from the standpoint of the formation of condensation in a problem much similar to that shown in the author's paper in Fig. 13. For this reason I would like to know if the author has been able to determine *when* condensation will form and *to what extent.* In my preliminary studies it was found that this problem is extremely complex because, as soon as condensation begins to form, the surface temperature approaches the wet bulb temperature instead of the dry bulb temperature of the air adjacent to that particular surface. Additional condensation continues to form because of this combination of cooling from the slab and cooling as indicated by the wet bulb temperature.

Since this problem of condensation is of definite importance when it occurs, I would like comments from the author on work of this type which he has done or anticipates doing.

C. B. Bradley, Manville, N. J. (Written): The author has illustrated the usefulness of his ingenious *Analogger* in solving practical problems. The three conditions discussed are all of practical interest. The last case, involving insulated walls and floors, serves to illustrate the effectiveness of the Analogger in handling problems of considerable complexity.

The curves of Fig. 4 appear not to be drawn so as to be consistent with the text. The text states:

The inside conductance f_i is assumed to vary in accordance with the values as given in Fig. 4, rising to a constant value of 1.65 for quiescent air at a distance of 8 in. from the inner corners......

In Fig. 4, however, f_i has a value of about 1.45 at the 8 in. distance and does not appear to be approaching a constant value at any distance.

Author's Closure: I would first call attention to the following corrections that are necessary in the preprint of the paper:

Equation 1 should read:

$$i = \frac{\Delta e}{r}; \; \Delta e = ir$$

in designation of units for resistance R in Figs. 2, 3 and 4, the symbol after "Btu" (in denominator) should be division sign "/" rather than dash.

Mr. Bradley is quite correct in pointing out the discrepancy in Fig. 4, where the values of the arbitrarily chosen curve for f_i at 7 in. from the corner should be 1.27; at 7.5, 1.40, and at 8, 1.65. The corresponding values for the resistance R should be 0.79, 0.71, and 0.61. Values outward from 8 in. on are constant and are taken as those for 8 in.

Mr. Everetts has drawn attention to a very significant problem occurring when cold surfaces are in contact with moisture-laden air. Up to the time when the surfaces in question are still dry, the air conductance is of low order and of value depending on the prevailing conditions of air motion and surrounding radiation. When condensation begins to form on the surfaces, however, the surface conductance changes and presumably goes up considerably, with resultant decrease in surface resistance. Under these circumstances, the nature of the heat flow in the area of condensation may then change, depending on the relative resistances of the thermal circuits, and accompanied by probable change in the surface temperatures. On the basis of Mr. Everetts' suggestion, the author plans to investigate these effects further.

President Woods returned to the chair and called for a report of the Resolutions Committee, which was presented by C. R. Gardner, Dallas, Tex., chairman, as follows:

Resolutions

Whereas, the 1947 Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, in Coronado, Calif., takes an enviable place in the annals of our Society, because of the job so well performed by the Southern California Chapter, its Committee on Arrangements, and many of its members, and

Whereas, many other individuals and organizations have also contributed much to this very successful meeting, therefore,

Be It Resolved, That the American Society of Heating and Ventilating Engineers adopt an expression of appreciation of the work they have done, and that copies be sent to the following:

◆

To Pres. Art Theobald and the Officers of the Southern California Chapter,

To R. A. Lowe, Chairman of the Committee on Arrangements, to its members and their ladies,

To the authors of the technical papers,

To Leo Hungerford, Toastmaster at the Banquet,

To Dr. Stafford Warren for his address at the Banquet,

To the Hotel del Coronado, its management and staff for their gracious hospitality and service,

◆

To the members of the Barber Shop Quartette, Messrs. Allen, Miller, Moffett and Snyder for their outstanding performance, both musically and as chefs de cuisine at the beach party,

To the newspapers and trade publications for their coverage of the meeting,

To the San Diego Convention Bureau for its cooperation in preparing for the meeting,

To the Chapters and members who continue to contribute toward the goal of retiring the Research Laboratory Mortgage.

Resolutions Committee

C. Rollins Gardner, *Chairman*
Melville G. Kershaw
Leon T. Mart

Announcement of the registration totaling 122 members, 30 guests and 65 ladies was made and the technical session adjourned at 12:00 noon.

DEEP SEA FISHING TRIP

By Lloyd Helms

On Monday at 12:30 p. m. twenty-four members of thte Izaak Walton League set forth on the Good *Ship Sport Fisher III* to try their luck on the briny deep. Our skipper, Jack Pierce, delivered us in due course to the kelp beds just off Point Loma, where the various members of the party took over with their individual ideas on how deep sea fishing should be done.

Neil Peterson of San Francisco admits to spending the greater part of his time at the rail without benefit of rod and reel. Howard Pound of Louisville, Ky., was credited with the largest fish. However, your reporter noticed that his purchases of weights were considerable and since the catch consisted of Large Mouth Calico Bass, we are wondering just how many sinkers he actually lost in the kelp beds. The skipper advised later that the total catch for the party amounted to about 200 fish. We also understand that Master Mittendorff of Chicago (age 7) returned his catch to the hotel and stored same in the hotel room closet for return to Chicago. We believe that by the following a. m. this situation had been corrected by the senior Mr. Mittendorff.

In spite of the foregoing, it has been reported that everyone had a good time and is looking forward to repeating the trip the next time the Southern California Chapter are so fortunate as to have the National Society as their guests.

SIGHTSEEING TRIPS

By Art Theobald

During the Coronado meeting the majority of the visiting members and ladies elected to take the sightseeing and inspection trips that were planned.

The Harbor Cruise left the boat house promptly at 2:05 p.m., but only twelve missed the boat. As we shoved off we set a course due east, which took us by the Naval Forces training grounds where we changed course from east to east by north until "Pickled Row" was in view, "Pickled Row" being the 1000 odd Naval ships that are in storage.

From there the course was changed to west down the channel toward the open sea, passing many ships of interest from submarines to submarine tenders, destroyers, destroyer tenders and LST's. Arriving at North Island, the entire party was taken aboard the carrier "Tarawa" for an inspection trip, after which the group was picked up and returned to the Coronado boat house.

For the twelve who missed the main harbor cruise, a small cabin cruiser was requisitioned to show them the highlights of the San Diego Bay area.

The Roads to Romance trip was a revelation and all who made it commented on the efficiency and knowledge of the bus driver. He certainly knew his San Diego, even to the point of calling all the flowers by their first names. The trip included a visit to Old Town, Ramona's Wedding Place and Balboa Park.

Maron Kennedy guided a group to the demonstration of the high altitude chamber to learn more of what happens to men and materials that are required to operate at high altitudes ranging to 50,000 ft and temperatures to 90 deg below zero.

Jack Everetts lead the contingent to the Naval Repair Base and "Pickled Row" to study the problems accompanying the procedure of storing a battleship and protecting it so that its return to service in a minimum length of time can be effected.

Over 100 attended the beach party to partake of their own handicraft at toasting wieners and marshmallows and to join in harmony with the Barber Shop Quartette.

OLD MEXICO

By Wm. N. "Bill" Pauley

After the last technical meeting on Wednesday, June 4, 54 members and guests had a very enjoyable trip to Old Mexico, *The Land of Manana*. They first visited Tiajuana where some purchased Mexican gifts of one kind or another, while others felt more inclined to have a closer acquaintance with that Mexican pastime, Tequila. Milt Hanna had a particularly fine time showing the natives how astute a good Yankee can be. He was the only one in the group who came home with anything even closely resembling a bargain.

After Tiajuana the crowd motored to Rosarito Beach where a *hot* Mexican dinner was enjoyed by all. On the return trip to the del Coronado, the group gave out with a gay roundelay of melody.

GOLF

By Bob Johnson

An afternoon of golf was enjoyed by the members at the San Diego Country Club, Chula Vista, on Monday, June 2, and when the final scores were turned in, Merrill F. Blankin, Philadelphia, past president of the Society, was the winner of the Research Cup, and the Southern California Chapter team, composed of F. B. Gardner, C. G. Hokanson and J. L. Blake, took possession of the Eichberg Memorial Cup.

Presentation of the Research Cup was made by L. P. Saunders, Chairman of the Committee on Research, at the Semi-Annual Banquet and then Mr. Blankin presented the Eichberg Memorial Cup to the President of the Southern California Chapter, Art Theobald. Announcement of the scores and the awards were made during the Banquet as follows:

Name	Gross Score	Handicap	Net Score	Award
M. F. Blankin	89	21	68	Golf Bag
F. B. Gardner	101	30	71	Zipper Bag
R. M. Johnson	84	12	72	Shag Bag
D. S. Bentley	91	19	72	Thermos Jug
C. G. Hokanson	87	13	74	Zipper Bag
J. L. Blake	100	24	76	Zipper Bag
Fred Kolb	104	28	76	Doz. Golf Balls
R. C. Chewning	98	22	76	Clock
W. F. Bishop	96	20	76	Poker Set
Ben Breslow	98	20	78	Chess Set
J. H. Milliken	92	14	78	Domino Set
M. W. Bishop	92	12	80	Golf Club Covers
C. E. Bentley	111	30	81	Jigger
Mrs. Ben Breslow	102	21	81	Doz. Golf Balls
W. O. Stewart	107	25	82	Barrel of Dates
M. M. Lawler	117	30	87	Cribbage Set
F. P. Bishop	117	30	87	Cigarette Lighter
C. Tasker	118	30	88	Jigger
L. P. Saunders	107	16	91	Carving Set
A. B. Banowsky	130	30	100	Book "Winning Golf"

PANEL HEATING COMMITTEE BEING ORGANIZED

On June 30 the newly appointed Committee on Panel Heating of the ASHVE held an all day session at the Society's Research Laboratory in Cleveland, Ohio. The meeting was conducted under the chairmanship of G. D. Winans, assistant superintendent of central heating, Detroit Edison Co., Detroit, Mich. and was called as the first step in the ASHVE Panel Heating Research Program.

G. D. Winans, Chairman
Panel Heating Committee

Members of the Research Laboratory staff reported results of a review and critical analysis of published data on the design of panel heating. This survey was made as a result of recommendations of the March conference group which was called for the purpose of discussing the proposed panel heating research program. Laboratory staff members also presented a summary of a field survey on the subject.

The committee designated four principal divisions for future research on the subject of panel heating. The divisions include heat distribution within and behind the panel, heat transfer between the panel and the space, comfort conditions and controls.

Each of these four divisions will become the responsibility of a special committee. Selections of special sub-committee personnel will be made from interested industry groups together with representatives of the ASHVE general membership.

The committee instructed the Research Laboratory staff to prepare detailed programs for study by the sub-committees. Following study and final approval by the subcommittees, the program will be presented to Society membership and industry for their support. It was pointed out that financial participation by both groups will be required to provide basic design data and to resolve the present apparent contradictions which face those persons interested in the installation of panel heating in homes, offices and industrial buildings.

John James, Vice Chairman
Panel Heating Committee

In addition to Mr. Winans, the personnel of the Committee on Panel Heating includes: Vice Chairman John W. James, research engineer, The Iron Fireman Manufacturing Co., Cleveland, Ohio; Prof. A. B. Algren, associate professor of heating, ventilating and air conditioning, University of Minnesota, Minneapolis, Minn.; R. L. Byers, chief engineer, John Paul Jones, Cary and Millar, Cleveland, Ohio; P. B. Gordon, treasurer, Wolff and Munier, Inc., New York, N. Y.; L. N. Hunter, vice president in charge of research, National Radiator Co., Johnstown, Pa.; J. S. Locke, sales manager, Air Conditioning Controls Division, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.; and H. F. Randolph, vice president, International Heater Co., Utica, N. Y.

ASSOCIATE GROUP ASSISTS MEMBERSHIP COMMITTEE

The Membership Committee of the Society, Messrs. M. W. Bishop, F. W. Hutchinson and H. R. Roth, will be assisted by an associate group selected from seven geographical zones, and by this means it is expected that there can be closer coordination with the Chapter Membership Committee's work in each area.

Mention of this committee appointment was made by President Woods in his mid-summer letter to members as follows: B. L. Evans, St. Louis, Mo.; R. S. Farr, Los Angeles, Calif.; O. J. Prentice, Chicago, Ill.; S. W. Salter, Montreal, Que.; E. C. Smyers, Pittsburgh, Pa.; J. A. Walsh, Houston, Tex.; Joe Wheeler, Jr., New York, N. Y.

The membership status as of July 31 is 5801, divided as follows: Charter Member 1; Honorary Members 2; Life Members 111; Members 2739; Associate Members 2508; Junior Members 310; Student Members 130.

A. L. CRUMP FORMS NEW COMPANY

According to a recent announcement the firm of A. L. Crump & Co., Chicago, Ill., has been formed and will represent Charles Demuth & Sons, Charles M. Bailey & Co., Flexitalic Gasket Co., Murray Iron Works Co., Stewart Mfg. Co., The Sims Co., and the Whittington Pump & Engineering Co.

Mr. Crump received a mechanical engineering degree from Heidelberg University in 1928. Upon graduating he joined the Powers Regulator Co., Chicago, Ill., as a sales engineer, later becoming manager of the Chicago contract sales department. During this time he was connected in the design and supervision of heating and air conditioning controls for such buildings as the Adler Planetarium, Sears Roebuck building, Chicago, Ill., and the Washington School, Maywood, Ill.

Mr. Crump has been a member of the Society since 1937 and is also an Illinois chapter member.

JAMES HOLT PRESIDENT, *ESNE*

At a recent meeting of the *Engineering Societies of New England*, James Holt, associate professor, mechanical engineering, Massachusetts Institute of Technology, was elected president.

Since joining the ASHVE in 1933, Professor Holt has served on the Publication Committee, both as a member and chairman; as president of the Massachusetts chapter from 1936-39, and as a member of the Council, 1943-45.

Professor Holt is well known in his field, having written many articles for New England plumbing and heating magazines and other publications.

G. V. SUTFIN FORMS NEW FIRM

G. V. Sutfin, formerly a sales engineer, with the American Blower Corp., Cincinnati, Ohio, has severed his connection with this company in order to form his own manufactures' agent business to assist purchasers in the selection and application of heat exchangers, economizers, condensers and air compressors, particularly in the fields of liquid and air engineering.

G. V. Sutfin

Since receiving his B.S. in mechanical engineering from the University of Michigan in 1932, Mr. Sutfin has had a well-grounded experience in his field. For three years he was a member of the engineering staffs of the Holland Furnace Co., and the National Brass Co. Prior to joining the American Blower Corp., in 1935, he was connected for a brief period with the Westerlin & Campbell Co., as a sales engineer.

Mr. Sutfin joined the Society in 1937 as an associate member advancing to full membership in 1942.

KIMBALL NAMES ASSOCIATE

Dwight D. Kimball, Life Member of the ASHVE, and past president, announced recently that Erik B. J. Roos has become his associate in his consultant engineering firm, 1728 Grand Central Building, New York, N. Y.

A graduate of Cornell University, Mr. Roos has done air conditioning work for important buildings in South America and Asia as well as the United States. During the war Mr. Roos served for three years as Lieutenant Colonel, Infantry, in North Africa, Italy, France and Germany.

HONEYWELL CHICAGO OFFICE IN NEW LOCATION

According to a recent announcement, the Chicago office of the Minneapolis-Honeywell Regulator Co., and its industrial division, the Brown Instrument Co., is now located at 351 East Ohio St., in larger quarters necessitated by expansion in business.

The Chicago regional office, which supervises activity and branch offices in various cities of Wisconsin, Illinois, Michigan, Indiana, Kentucky, Tennessee, Missouri, Arkansas, Kansas and Iowa, will have three times as much space than in its former quarters.

AIEE ELECTS OFFICERS

As announced at the annual meeting of the *American Institute of Electrical Engineers,* held in Montreal, June 11, 1947 the new officers elected are: B. D. Hull, *president*, G. W. Bower, J. H. Berry, I. M. Ellestad, D. I. Cone, D. G. Geiger, *vice presidents;* W. L. Everitt, A. C. Monteith, E. B. Robertson, *directors;* and W. I. Slichter, *treasurer.*

TELEVISION PROGRAM FEATURES A.C. UNIT

On a program originating from *KSD*, St. Louis, Mo., one of the new television stations in the country, ASHVE member D. J. Fagin explained the workings of an air conditioning unit. As he assembled the unit, which heats as well as cools the air in modern homes, the various operations were explained in simple, nontechnical language. The question and answer script used for this telecast was prepared by Mr. Fagin in collaboration with Harold Grams, *KSD* program director.

Mr. Fagin has been a member of the Society since 1932 and is active in the affairs of the St. Louis Chapter. He is assistant to the general sales manager of the Laclede Gas Light Co.

During this telecast shown on May 28, *KSD* was able to pick up the smallest objects in the model even to the point where minute letters on the switches could be read by observers. The program was well received and resulted in a number of interested inquiries.

D. J. Fagin and Louis Rice, district representative of Servel, Inc., discuss workings of A.C. unit before television camera in the studios of KSD with Harold Grams, KSD program director, looking on

HONOR O. J. PRENTICE

At a dinner given by the officials of the C. A. Dunham Co., Chicago, Ill., Oliver J. Prentice, life member of the ASHVE, was honored on his 80th birthday and for 27 years service with the company.

He has been associated with the C. A. Dunham Co. since 1921, when he was appointed manager of the advertising department. At present he is serving as director of publicity and public relations.

Mr. Prentice joined the Society in 1927 and became a life member in 1942. He has always taken an active interest in the affairs of the Society and has participated in many of the meeting programs. President of the Illinois chapter of the ASHVE during the 1946-47 season, he is a past chairman of the Illinois Committee of the *Chicago Association of Commerce and Industry*.

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W. T. JONES, PAST PRESIDENT, DIES

The sudden passing of William T. Jones, Boston, Mass., has saddened his many friends in the engineering profession and his associates in the Society. A heart attack proved fatal to Mr. Jones on July 19, 1947, as he was preparing for a brief vacation in Maine. He would have been 64 on August 14.

Born in Peaks Island, Portland, Me., in 1883, Mr. Jones attended Portland schools, and in 1909 was graduated from the Lowell School of the Massachusetts Institute of Technology. Following his graduation Mr. Jones entered the drafting room of the Whittier Machine Co. He spent a brief period with the B. F. Sturtevant Co., Hyde Park, Boston, and the Boston Elevated Railway Co., where he was employed in the design and drafting department. At the Thermograde Valve Co., which he joined in 1912, he became acquainted with William E. Barnes, and this association led to the partnership in 1921 of Barnes & Jones. For a number of years he was in charge of the New England territory for Consolidated Engineering Co. Mr. Jones had completed 26 years as a manufacturer of heating specialties and was treasurer of Barnes & Jones, Inc., at the time of his death.

W. T. Jones

An intense interest in the work of the Society was an outstanding characteristic of Mr. Jones. He joined in 1915 and served the Society in many capacities. He was president in 1933, first vice president in 1932, second vice president in 1931, and a member of the Council from 1925 to 1934. Among his important committee assignments were: chairman of the Finance Committee during one of the crucial periods of Society history, chairman of the Committee on Revision of the Constitution and By-Laws for many years, member of the Committee on Research, Nominating Committee, Committee on Admission and Advancement, and many technical committees. In addition Mr. Jones served as a member of the F. Paul Anderson Award Committee for four consecutive years, and at the time of his death, besides serving as chairman of the Constitution and By-Laws Committee, he was a member of the History Committee and the Advisory Council. Through his wide knowledge of Society activities and functions he was largely responsible for drafting the present Constitution of the Society.

He was very active in the work of the Massachusetts Chapter and served as its president in 1923 and 1924, and on the Board of Governors in 1925, 1936, and 1937. When the chapter was host to the Society in 1925, 1931 and 1937, he had an active role in the arrangements.

He served as advisory chairman of the Committee on Arrangements for the 51st Annual Meeting held in Boston in January 1945, and was toastmaster at the annual banquet.

Mr. Jones was a familiar figure at Society meetings for many years and often remarked that his closest friendships, both personal and in business, resulted from his attendance at meetings. He was a plain spoken man of high ideals and strong convictions, and many splendid tributes to his memory have been received and are treasured by his family.

A fitting description of Mr. Jones, taken from *Songs of the Workaday World* by Berton Braley, was quoted at the services for him:

THE LIVING EPITAPH

When I pass out and my time is spent,
I hope for no lofty monument,
No splendid procession marching slow,
Along the last long road I go;
No pomp and glory I care for then,
When I depart from the world of men.

But I'd like to think when my race is through
That there will be in the world a few
Who'll say, "Well, there is a good man gone,
I'm sorry to see him passing on,
For he was a sort that's fair and square,
The kind of fellow it is hard to spare.

"He hadn't money, he hadn't fame,
But he kept the rules and he played the game,
His eyes were true and his laugh was clear,
He held his truth and his honor dear.
And now that his work is at an end,
I know how much I shall miss my friend."

If my life shall earn such words as those
I shall smile in peace as my eyelids close,
I shall rest in quiet and lie content,
With the words of a friend for my monument.

Funeral services were conducted on Monday, July 21, at the Newton Cemetery Chapel in the presence of 200 relatives and friends.

Mr. Jones leaves his widow, Mrs. Freida Jones; a daughter, Ruth; a son, Howard; one grandson; a brother, and his 93 year old mother, to whom the Officers and Council of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS extend their deepest sympathy for the great loss they have sustained.

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DEATH OF HENRY MATHIS

Henry Mathis, Chicago, Ill., prominent in the fan industry and a member of the Society for 26 years, died on July 18, 1947, in Wesley Memorial Hospital.

Born in Chicago, August 8, 1891, Mr. Mathis was graduated from high school and attended Kent Law College. His entire professional career was spent in the service of the New York Blower Co. After three years of drafting, he devoted his time almost exclusively to the compilation of engineering data, fan testing and the layout of heating and ventilating systems. At the time of his death he was executive vice president and sales manager of the company.

Mr. Mathis had been active in the affairs of the Illinois chapter of ASHVE and he was a past president of the *National Association of Fan Manufacturers* and the *Industrial Unit Heater Association.*

The Officers and Council of the American Society of Heating and Ventilating Engineers extend their deepest sympathy to his survivors: his widow, Ethel; three daughters, Ethel Mary, Mrs. Beatrice M. Mix, and Mrs. Jeanette M. Horine; and a son, Julien W. Funeral services were held on July 21.

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A. G. WHELER SUCCUMBS OF HEART ATTACK

A. Gordon Wheler, engineer, Syracuse, N. Y., died on July 15, 1947, after suffering a heart attack while trying to man a sailboat during a windstorm. He was a member of the Society and of the Central New York Chapter since 1945.

Born on April 21, 1890, in Stouffville, Ont., Canada, Mr. Wheler received his preliminary education at Edgewood Park, Pa., high school. In 1907 he was graduated from Woodstock College, Ontario, Canada, and in 1912 completed his mining engineering studies at the University of Toronto, graduating with a B.A. in science.

From 1912 until 1929 Mr. Wheler was engaged in the lumber business in the U. S. Returning to Canada in 1929, he joined the Even-Heat, Ltd., as a sales engineer and in 1930 he became president of Syracuse Even-Heat Inc. After being associated for a short time with the Lennox Furnace Co., Syracuse, N. Y., he started his own firm, which he maintained from 1932-35. For the next seven years Mr. Wheler represented several firms in Syracuse and was active in the design and installation of stokers, forced air heating systems, and industrial exhaust and ventilating systems. At the time of his death he was employed as an engineer by the House Sheet Metal Co., Syracuse.

Mr. Wheler leaves his widow, Mrs. Frances H. Wheler; a daughter, Anne Wheler, and a son, A. Gordon Wheler, Jr., to whom the Officers and Council of the American Society of Heating and Ventilating Engineers extend their heartfelt sympathy.

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CLAUDE L. WINTER DIES

Claude L. Winter, a member of the Society since 1944, died February, 1947, according to word received recently.

Mr. Winter, who was 64 years old at the time of his death, was a native of Langston, Mich. During a major portion of his professional career he was engaged in the installation of stokers and automatic controls. At the time of his death he was representing the Link-Belt Co., 50 N. Division Ave., Grand Rapids, Mich.

The Officers and Council of the American Society of Heating and Ventilating Engineers extend their sympathy to his family.

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H. S. DENHAM DIES AT 65

Howard S. Denham, a member of the Society since 1939, died on June 30, 1947, in Malden, Mass., after a long illness.

A native of Pepperell, Mass., Mr. Denham was born on July 18, 1881. After attending the Pepperell High School, he entered the Massachusetts Institute of Technology, where he studied electrical engineering.

Mr. Denham's extensive experience in engineering fields included 2 years with the Thompson & Lichtner Co., Boston, Mass., as a draftsman and field engineer; eleven years with Boott Mills, Lowell, Mass., supervising repairs and improvements, and six years with the N. E. Telephone & Telegraph Co. as a cable engineer. He received a citation for his work on the atomic bomb during the war, when he was employed by the Stone & Webster Co.

In addition to being a member of the ASHVE, Mr. Denham was also affiliated with the *Associated Engineering Societies of New England.*

He is survived by his wife, a daughter, Margaret, and an aunt, Miss Nellie E. Everson, to whom the Officers and Council of the American Society of Heating and Ventilating Engineers extend their deepest sympathy.

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DEATH OF C. F. WHITTON

C. F. Whitton, sales engineer, Chatco Steel Products Ltd., Toronto, Ont., Canada, passed away a few weeks ago.

A native of Chicago, Ill., Mr. Whitton received his education at Loyola College, and McGill University, Montreal, Canada. His first position was as a draftsman for the Youngstown Sheet and Tube Co., Youngstown, Ohio. In 1911 he joined the Steel Co., of Canada Ltd., as an assistant secretary. Following this position, he was employed by the Construction Products Ltd., as manager. In 1934, he became manager and operating superintendent for the Packaged Fuels Ltd. At the time of his death Mr. Whitton was employed by the Chatco Steel Products Ltd., as a sales engineer, estimating heating equipment sizes and building requirements.

Mr. Whitton had been an associate member of the Society since 1945, and had also been a member of the *Engineering Institute of Canada.*

The Officers and Council of the American Society of Heating and Ventilating Engineers extend their deepest sympathy to his survivors for their sad loss.

Summary of Local Chapter Meetings*

CONNECTICUT—June 26, 1947. Subject: Annual non-technical meeting and outing. Members and their guests enjoyed a golf outing. This was followed by dinner and an entertaining talk by Michael Coyne, Springfield, Mass. All regular business was dispensed with. Attendance 60. Attendance ratio 0.30.

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KANSAS CITY—June 5, 1947. Election of new officers was announced as follows: P. C. Leffel, *president;* H. E. Gould, *vice president;* Henry Nottberg, Jr., *secretary;* K. M. Stevens, *treasurer;* S. L. Furber, *chairman,* and Carl Clegg, N. W. Downes, W. L. Cassell, as *board of governors.* Reports of the Smoke Abatement committee, and the treasurer were given. The meeting was turned over to Mr. Leffel, incoming president, who presented the past president's certificate to Mr. Furber, retiring president. Attendance 28.

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MEMPHIS—June 16, 1947. A report was given that the treasurer's records had been audited and found satisfactory. Pres. N. C. Ledbetter, the chapter's delegate to the Semi-Annual meeting gave a report on the meeting. He mentioned that chapter contributions to the fund to reduce the mortgage on the Research Laboratory amounted to nearly half the amount required. A general discussion followed in which programs for future meetings were formulated. Attendance 0.52.

NEW YORK—May 19, 1947. Subject: New Developments in the Concentration of Energy. Speaker: John Arnold, vice president, Hydrocarbon Research Inc., New York, N. Y. Mr. Arnold illustrated his subject, which covered the up grading of low heat value fuels, by means of slides. A rising vote of thanks was accorded Mr. Arnold for his interesting talk and for his able handling of the discussion period which followed. Other Features: Pres. W. A. Sherbrooke introduced the newly elected officers. Attendance 65. Attendance ratio 0.16.

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NORTH TEXAS—June 16, 1947. The first summer stag party of the North Texas chapter was held in Vickery Park and was a great success. Entertainment consisted mainly of a lively ball game which was followed by a stag dinner. The reading of the May minutes, as well as all other business was postponed until the next meeting. Attendance 43.

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NORTHERN OHIO—June 20, 1947. Subject: Annual Golf Outing. An afternoon of golf was enjoyed by members and guests. At a dinner which followed, both the retiring and new officers were introduced. No further business was transacted. Attendance 81.

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ST. LOUIS—April 8, 1947. Subject: New Developments in the Field of Residential Heating. Speaker: E. A. Freund, Union Electric Light and Power Co., of Missouri, and General Engineering and Mfg. Co. Mr. Freund discussed an experimental installation recently made by his company, in a residence located in Kirkwood, Mo. This heat pump installation, he stated, utilizes the rather uniform temperature below the frost line for heating in the wintertime and cooling in the summertime. President Simons thanked Mr. Freund on behalf of the St. Louis chapter for his excellent talk. Other Features: Reports were given by the treasurer and by the chairman of the membership committee. The nominating committee reported on a slate of officers for the coming year. Attendance 85.

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SOUTH TEXAS—June 21, 1947. An annual picnic held in MacGregor Park, proved very enjoyable to members and their guests. No regular business was transacted since this picnic was held in place of the regular monthly meeting of the South Texas chapter. Attendance 26.

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SOUTHERN CALIFORNIA—June 6, 1947. Subject: Theory and Practice of Electrostatic Precipitators. Speaker: James W. May, director of research, American Air Filter Co., Louisville, Ky. In his interesting lecture, Mr. May discussed the electrical theory of matter together with the practical application of this theory to electric precipitators. Other Features: New officers for the coming year were installed. Several reports were given regarding the Society's Semi-Annual Meeting held at Coronado, Calif., and an announcement was made concerning an *ASRE* meeting. Attendance 89.

SOUTHERN CALIFORNIA—May 14, 1947: Subject: Humidity and Its Control. Speaker: John Everetts, Jr., consulting engineer, San Francisco, Calif. Some of the points touched by Mr. Everetts in his interesting talk were the advantages and disadvantages of solid and liquid sorbents, and the cost of refrigeration *vs.* sorbents. Other Features: The following officers were elected: R. A. Lowe, *president;* R. S. Farr, *vice president;* J. L. Blake, *secretary;* L. J. Helms, *treasurer;* L. B. Davenport, J. L. McCullough, Nicholas Nassir, and Art. Theobald, as *board of governors.* Attendance 58.

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*Note: The attendance ratios shown represent the membership attendance divided by the chapter membership. These ratios will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by the various chapters and may be useful in deciding on subjects for chapter meetings.

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Western Michigan—May 19, 1947. Subject: Annual Meeting and Sports Outing. A tour through the Duo Therm Div., Motor Wheel Corp., was also arranged and well attended by the members. Following dinner, reports were given by the officers and chairmen of the preceding year, and new officers were sworn in. Members enjoyed an account of his experiences given by Mr. Dougherty, line coach at Michigan State College, and colored movies of a canoe trip through Northern Canada, taken by Clarence Munn, football coach at Michigan State College, were shown. Attendance 66.

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Wisconsin—May 19, 1947. Subject: Triethylene Glycol in Air Conditioning Systems. Speaker: Dr. W. A. Schlesinger, chemical engineer, Air and Refrigeration Corp., New York, N. Y. Dr. Schlesinger explained the chemistry of triethylene glycol. Slides were used to explain the technical details and the mechanical application of the equipment used in air conditioning systems. His excellent discussion of this subject was enjoyed by all. Other Features: Reports of the various committees were given. Officers elected for the coming year include: J. R. Vernon, *president;* W. A. Ouweneel, *vice president;* W. H. Stevens, *treasurer;* B. M. Kluge, *secretary;* E. W. Gifford and H. W. Schreiber, *board of governors.* Attendance 41.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 36 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by August 25, 1947, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

Boemi, Henry, Engr., Albert Fentzlaff Inc. Proposers: Albert Fentzlaff*, J. E. Werther*. Seconders: P. L. Rhodes*, T. M. Reed, Jr.

Brown, E. Burt, Pres., Reynolds Corporation. Proposers: A. P. Brown, C. E. Wolfe, Sr. Seconders: M. J. Bamond, G. W. Bornquist.

Case, D. V., Jr., Chief Mechanic, J. Gordon Turnbull, Inc., Proposers: D. V. Case, Henry Gould. Seconders: Henry Nottberg, Jr., P. C. Leffel.

Cordes, Elmer W., Sales Engr., Union Electric Co. of Missouri. Proposers: R. M. McQuitty, M. F. Carlock. Seconders: B. C. Compton, E. E. Carlson.

Dean, Francis F., Engr., J. E. Sirrine & Co. Proposers: G. R. Morgan, R. A. Stipp. Seconders: D. P. Schiwetz, I. B. Kagey, Jr.

Driggs, Alfred A., Jr., Mgr., Westinghouse Electric Corp., Sturtevant Div. Proposers: Abraham Bassevitch, D. J. Whealton. Seconders: Arthur Beutel*, H. F. Brush*.

El Attar, A. A., Engr., "Koldair", S.A.E. Proposers: M. E. Tahry, A. R. Fayed*. Seconders: Kamal Ezz-El-Din, S. Mohsin*.

Elgin, Richard D., Pres., General Air Conditioning Corp. Proposers: A. W. Shelby, G. S. Flinn. Seconders: J. J. Nolan, J. D. Flinn.

Ely, John W., Sales Engr., Minneapolis-Honeywell Regulator Co. Proposers: R. A. Donie, C. F. A. Locke. Seconders: W. W. Grear, J. F. Cummiskey.

Fleming, Clarence L., Owner, Fleming Refrigeration Co. Proposers: F. C. Brandt, C. C. Quin. Seconders: L. L. Ladewig, R. M. Roberts.

Haffey, John P., Gen. Mgr., W. P. Payne Co. Proposers: J. Herman, Jr., I. E. Mayne. Seconders: A. J. Hess, C. W. Pollock.

Helle, Frank J., Republic Heaters Co. Proposers: F. T. Goodwin, J. E. Sharp*. Eugene Reichelt, F. A. Furlong*.

Johnson, S. C., Partner, Burnett-Johnson Appliance Co. Proposers: T. H. Anspacher, J. A. Ray. Seconders: E. T. Gessell, J. D. Poythress.

Klein, Irving R., Archt. Proposers: H. W. Broadwell, I. A. Naman. Seconders: J. A. Walsh, C. L. Boehler.

Koenig, Max, Chief Engr., Louis de Roll Iron Works, Ltd. Proposers: A. J. Offner, W. Teglin*. Seconders: P. E. Soutter*, E. M. Lewis, Jr.*.

Leatherwood, T. W., Pres., Contracting Engineers, Inc. Proposers: A. M. Chase, Jr., C. L. Boehler. Seconders: H. C. Will, J. A. Walsh.

Leonard, Allison F., Dist. Mgr., J. R. Dowdell & Co. Proposers: B. P. Fisher, C. C. Quin. Seconders: J. A. Walsh, D. S. Cooper.
Leslie, Donald G., Vice-Pres., The Torrington Manufacturing Co. Proposers: W. G. Boales, E. N. McDonnell. Seconders: J. W. Miller, Donald Luty.
Lichten, Earl B., Mech. Engr., Consoer, Townsend & Associates. Proposers: James Peebles*, S. I. Cole*. Seconders: George Coleman*, Charles Goldberg*.
Loeffler, John G., Sales Engr., Federal Supply Co. Proposers: F. M. Thomas, E. F. Dawson. Seconders: W. W. Frankfurt, J. H. Carnahan.

Mazer, Joseph L., Student, University of Illinois. Proposers: R. J. Martin*, J. C. Miles*. Seconders: S. Konzo, J. R. Carroll, Jr.
Murray, Robert P., Customer Service, East Ohio Gas Co. Proposers: W. E. Olmsted*, P. H. Burkett*. Seconders: L. G. Griebling*, Al Horstkamp*.
Muzio, Andrew H., Mech. Engr., Huffman Wolfe Co. Proposers: E. K. Jamison, A. C. Gowdy. Seconders: W. J. McKinney, Leo Sudderth, Jr.

Osgood, Harry P., Sales Engr., Fulton Sylphon Co. Proposers: W. H. Old, K. L. Wilson. Seconders: G. W. Akers, Marshall Bruce.

Pride, Charles F., Mech. Engr., The Austin Co. Proposers: D. P. Holmes, D. F. Owens. Seconders: R. A. Parker, J. E. Murray.

Reiley, T. D., Sales Engr., Johnson Service Co. Proposers: K. A. Wright, R. W. Sigmund, Seconders: H. K. Jennings, K. B. Little.
Rupert, James D., Engr., Miller Davis Plumbing & Heating Co. Proposers: O. D. Marshall, W. W. Bradfield, Jr. Seconders: T. D. Stafford, M. A. Lett.

Sheridan, Thomas J., Burns Bros. Proposers: F. W. Hanburger, J. M. Kipe. Seconders: M. B. Shea, T. R. White.
Singer, Joseph H. Application Engr., General Electric Co. Proposers: R. U. Berry, F. H. Faust. Seconders: D. W. McLenegan, W. F. R. Karsten*.
Smith, Alan M., Engr., Otis Massey Co. Proposers: E. F. Yates, G. A. Fullington. Seconders: B. L. Shannon, C. S. Woodruff.
Stansbury, Edward J., Jr., Sales Engr., Mundet Cork Corp. Proposers: W. J. Way, E. G. Floeter, Jr. Seconders: D. S. Cooper, C. C. Quin.

Tooke, Thomas B., Equip. Engr., Long Theatres. Proposers: E. G. Floeter, Jr., N. J. Way. Seconders: D. M. Mills, F. C. Brandt.
Torry, Charles, Chief Engr., J. H. Lock & Sons, Ltd. Proposers: H. M. Treleaven, A. M. Dion. Seconders: W. W. Miller, H. R. Roth.

Walker, Carl L., Sales Engr. & Mfrs. Repr. Proposers: W. B. Morrison, J. D. Kroeker. Seconders: F. F. Urban, T. H. McClung.
Wessler, George H., Jr., Dist. Repr., General Electric Co. Proposers: J. P. Turner, Jr., W. F. R. Karsten*. Seconders: P. R. Lynn*, E. A. Rapp*.
Winner, Robert J., Test Engr., General Electric Co. Proposers: W. T. Miller, C. F. Warner. Seconders: D. S. Clark*, A. N. Spalding*.

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*Non-Member.

Candidates Elected

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by **Art. B-III**, *Section* 8, of the By-Laws, the following list of candidates elected:

Members

Bachman, William L., Indus. Htg., Vent. & Air Cond. Engr., Tucker & Rice, Inc., Worcester, Mass.
Baker, John G., Chief Engr., Viking Manufacturing Corp., Cleveland, Ohio.
Baldwin, Karl F., Jr., Cons. Engr., Clyde E. Bentley, Oakland, Calif. *(Advancement.)*
Bennis, Raymond R., Chief Engr., Contractors Refrigeration Corp., Elmhurst, N. Y. *(Advancement.)*
Blum, Herman, Jr., Cons. Engr., Dallas, Tex. *(Advancement.)*
Bradfield, William W., Sales Engr., Wilson-Brinker Co., Kalamazoo, Mich. *(Advancement.)*

Chinn, George I., Chief Engr., Gerotor May Corp., Baltimore, Md.
Cooke, Walter, Mfrs. Repr., New Orleans, La.
Crose, Oliver P., Sales, Murphy & Miller, Inc., Chicago, Ill.

Dillard, Joseph P., Mfrs. Repr., Dallas, Tex.
Dunn, Aubrey N., Plant Engr., S. C. Johnson & Son, Inc., Racine, Wis.

Erickson, Einar T., Research Engr., University of Minnesota, Minneapolis, Minn.

Fischer, William F., Chief Engr., Edison Marquette Co., Chicago, Ill.
Fisher, Ernest F., Engr., Faraday Engineering Co., York, Pa.

Ganter, Carl F., Partner, Westville Electric Co., New Haven, Conn.
Grady, Edmund J., Sales Mgr., Pacific Steel Boiler Div., U. S. Radiator Corp., Detroit, Mich.

Hyde, Bruce P., Engr., Hill & Harrigan, New Haven, Conn.
Hyman, Charles A., Asst. Chief Pr. & Fuel Engr., Carnegie Illinois Steel Corp., Youngstown, Ohio.

Jesperson, Svend F., Cons. Engr. Copenhagen, Denmark.
Jones, Arthur L., Dist. Mgr., American Blower Corp., Syracuse, N. Y.
Jones, F. Chandler, Jr., Equipment Engr., Sturtevant Div., Westinghouse Electric Corp., Boston, Mass.

Kliever, Waldo H., Research Dir., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Kramer, John J., Appl. & Design Engr., American Blower Corp., Detroit, Mich.

Lindahl, Eric J., Assoc. Prof. of Mech. Engrg., Ohio State University, Columbus, Ohio.

Martin, Thomas B., Chief Engr., Burden Co., Los Angeles, Calif.
Maycock, Ambrose A., Mgr., A. A. Maycock Co., Salt Lake City, Utah *(Advancement.)*
Midgley, Rushby C., Partner, Midgley-Huber, Salt Lake City, Utah.

MORGAN, FRANK X., Chief Mech. Engr., Mahony-Troast Construction Co., Passaic, N. J.
MURRAY, FRANCIS A., Vice-Pres., The Powers Regulator Co., New York, N. Y.

RIES, AUGUST S., JR., Research Dir., Despatch Oven Co., Minneapolis, Minn.

SANFORD, ELLWOOD C., Sales Application Engr., Fred W. Kolb, San Francisco, Calif.
SHAFER, MARVIN L., Engr., Walter W. Ahlschlager & Associates, Dallas, Tex.
SIMPSON, CARL E., Mech. Engr., R. A. Rankin & Co., Montreal, Que., Canada.
SNIDER, CLAY T., Sales Engr., Minneapolis-Honeywell Regulator Co., San Francisco, Calif.
SONTAG, HARCOURT C., Engr., U. S. Navy Department, Washington, D. C.
STOLBERG, CHARLES P., Chief Mech. Engr., The H. K. Ferguson Co., Cleveland, Ohio.

VAN NIEUKERKEN, J. M., Consultant, Copper & Brass Research Association, New York, N. Y.
VON ROSENBERG, PAUL C., Prod. Application Engr., Allegheny Engineering Co., Johnstown, Pa. *(Advancement.)*

WALLEN, GEORGE R., Asst. Chief Engr., Anemostat Corporation of America, New York, N. Y.

Associate Members

AIKEN, HECTOR H., Special Research Asst., University of Illinois, Urbana, Ill.
ALGER, IRVING G., Mech. Engr., G. M. Simonson, San Francisco, Calif.

BAILEY, GEORGE G., Htg. & Air Cond. Engr., Boynton Cole, Atlanta, Ga.
BARBECK, CHESTER A., Sales Engr., Matthews Engineering Co., Dallas, Tex.
BARTLETT, GEORGE M., Sales & Application Engr., Gulf Oil Corp., New Haven, Conn.
BRENNAN, CHESTER T., Dist. Repr., Titusville Iron Works, Titusville, Pa.

CONRAD, ALTON F., JR., Engr., Avery Engineering Co., Cleveland, Ohio.
COOPER, BENJAMIN G., Design Engr., Dunn Manufacturing Co., Holland, Mich.
COOPER, KENNETH G., Designer, Richard A. Belsham, Miami, Fla.
CORBMAN, ALBERT L., Director, Massachusetts Department of Public Health, Boston, Mass.

DARBY, J. WILSON, Owner, J. W. Darby Co., Houston, Tex.
DAUGHERTY, ROBERT J., Htg. Engr. & Supvsr., The Zero Co., Cincinnati, Ohio.
DAY, L. CARROLL, Owner & Gen. Mgr., Day-York Distributors, Portland, Ore.
DEMUTH, HERBERT, Partner, Charles Demuth & Sons, Mineola, L. I., N. Y.
DOW, CLIFFORD H., Engr., Minneapolis-Honeywell Regulator Co., Boston, Mass.
DUNCAN, HERB L., Combustion Sales Engr., Natural Gas Equipment, Inc., San Francisco, Calif.

EZELL, PHILIP B., Sales Engr., Bryant-Brown Co., Houston, Tex.

FARKAS, FRANK S., Htg. & Vent. Engr., V. J. Hagan Co., Inc., Sioux City, Ia.
FISCHER, FRED C., Vice-Pres., Sink & Edwards, Indianapolis, Ind.
FRANKENFELD, HENRY V., Mech Engr., Federal Supply Co., Oklahoma City, Okla.

GISH, WILBUR A., Indus. Sales Engr., Northwestern Electric Co., Portland, Ore.
GOERG, ROBERT A., Director, Goerg & Co., Geneva, Switzerland.
GOMBERT, FREDERICK S., Sales Mgr., Hall-Neal Furnace Co., Indianapolis, Ind.
GRAY, STANLEY A., Sales Engr., Minneapolis-Honeywell Regulator Co., Chicago, Ill.
GROSS, CHARLES J., Draftsman, Sun Oil Co., Philadelphia, Pa.
GUIBERT, RAUL, Contr. Engr., Buenos Aires, Argentina, S. A.

HAIRSTON, JOSEPH T., Sales Mgr., H. J. Swanson Co., Long Beach, Calif.
HANEY, ARNOLD A., Mgr., Refrig. & Air Cond. Dept., N. O. Nelson Co., Houston, Tex.
HARTNETT, DANIEL E., Htg. Estimator, Wigman Co., Sioux City, Iowa.
HICKS, BEATRICE A., Vice-Pres. & Chief Engr., Newark Boiler Regulator Co., Bloomfield, N. J.
HOAGLAND, EVERETT J., Sales Engr., Johnson Service Co., Boston, Mass.
HOGUE, MARION R., Sales Engr., Capitol Supply Co., Lincoln, Nebr.
HOWARD, WESLEY B., Sales Engr., Baker Ice Machine Co., Inc., Omaha, Nebr.
HUDSON, R. BURTON, JR., Sales Engr., Air Products Co., Chicago, Ill.
HURST, STEPHEN G., Sales Promotion, American Radiator & Standard Sanitary Corp., San Francisco, Calif.
HUTCHINS, PAUL C., Sales Engr., The Trane Company, New York, N. Y.

JACOBS, ROBERT H., Application Engr., Minneapolis-Honeywell Regulator Co., Milwaukee, Wis.
JOCKEL, HUGH C., Dept. Mgr., Engrg. Sales, Grinnell Company of Canada, Ltd., Montreal, Que., Canada.

KABER, WILLIAM C., Steam Sales Engr., Union Electric Company of Missouri, St. Louis, Mo.
KER, ROBERT J., Sales Mgr., Air Cond. Div., Canadian General Electric Co., Ltd., Montreal, Que., Canada.
KINGSBURY, J. WARREN, Pres., Chester Utilities, Inc., New York, N. Y.
KLEIN, EDWARD W., JR., Partner, E. W. Klein Co., Atlanta, Ga.

LARSON, CHARLES E., Engr. & Sales Mgr., International Sales Co., San Francisco, Calif.
LARSON, HAROLD B. R., Partner, The Markson Co., Mound, Minn.
LAY, ROBERT M., Engr., Royal Air Conditioning Co., Houston, Tex.
LEDGETT, F. DONALD, Mech. Engr., Board of Education, Toronto, Ont., Canada. *(Reinstatement.)*
LEISING, RALPH E., Proj. Engr., Avery Engineering Co., Cleveland, Ohio.
LINDSAY, D. LORNE, Engr., G. Lorne Wiggs & Co., Montreal, Que., Canada.

MARCH, MARION J., Sales Engr., Neil H. Peterson Co., San Francisco, Calif.
MARSCHALL, ERNEST H., Htg. & Vent. Engr., Francisco & Jacobs, New York, N. Y.
MATTHEWS, OWEN W., III, Sales Engr., William S. Turner & Co., Portland, Ore.
MCGOVERN, TOM R., Pres. & Gen. Mgr., The Baxter-Nafz Co., Springfield, Ohio.
MCROBERTS, ROBERT C., Draftsman, Natkin & Co., Houston, Tex.
MINICK, ALVIN L., Chief Machinists' Mate, U. S. Navy, Washington, D. C.
MORGAN, W. RALPH, Partner, Products Engineering Co., Atlanta, Ga.
MORRISON, MORTON M., Field Supervsr., Air Conditioning Applications Co., Montreal, Que., Canada.

O'CALLAGHAN, LELAND J., Vice-Pres. & Gen. Mgr., Dealers Supply Co., Inc., Atlanta, Ga.
ORR, PATRICK W., Pres., Del-Patrick Inc., Denver, Colo.
OSLUND, DANIEL L., Htg. Engr., Department of Buildings, Minneapolis, Minn.

OWEN, PAUL H., JR., Foreman, Charles G. Heyne Co., Houston, Tex.

PETTY, ARTHUR V., Mgr., Graves Refrigeration, Inc., Atlanta, Ga.
PFEIFER, VICTOR A., Supt., Acme Metal Works, Portland, Ore.
PIERCY, ARTHUR K., Mech. Engr., Green, Blankstein, Russell, Winnipeg, Man., Canada.
POLLITT, STERLING H., Chief Engr., Eaton Knitting Co., Hamilton, Ont., Canada.
POTTEIGER, CHARLES A., Pres., Reading Heater & Supply Co., Inc., Reading, Pa.

RAYL, LAWRENCE B., Air Cond. Engr., Southern California Gas Co., Los Angeles, Calif.

SCHOEDEL, JOSEPH J., Supvsr., Proie Bros., Pittsburgh, Pa.
SCHWIND, L. MORGAN, Mgr., Hester-Bradley Co., St. Louis, Mo.
SHIELDS, CARL D., Engr., Design Div., E. I. DuPont de Nemours & Co., Wilmington, Del. *(Reinstatement.)*
SHILLER, BENJAMIN P., Chief Estimator, Young Brothers Co., Detroit, Mich.
SMITH, ERIC H., Tech. Asst. to Sales Dir., The Standard & Pochin Bros., Ltd., Leicester, England.
STARK, J. EMIL, Estimator, Wray M. Scott Co., Inc., Omaha, Nebr.
STEADMAN, CLIFFORD C., JR., The Bahnson Co., Winston-Salem, N. C.
SWANSON, HERBERT J., Owner, H. J. Swanson Co., Long Beach, Calif.
SWEENEY, ALLAN R., Estimator & Engr., The Huffman-Wolfe Co., Columbus, Ohio.

WAGNER, RICHARD E., Chief Engr., H. J. Swanson Co., Long Beach, Calif.
WAHNQUIST, CARL J., JR., Crane Co., New Haven, Conn.
WILLIAMS, FRANK K., Mech. Engr., Public Works Dept., State Government of Victoria, Australia.
WOOD, FRANKLIN J., Vice-Pres., Wood Motor Co., Eau Claire, Wis.

Junior Members

ANDERSON, JAMES T., Instructor, Michigan State College, East Lansing, Mich.
ANDREW, GORDON J., Htg. & Indus. Engr., W. T. Andrew Co., Detroit, Mich.

BRANDT, SANFORD S., Application Engr., Matthews Engineering Co., Dallas, Tex.
BUCK, WILLARD B., Instructor, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
BURT, RALPH L., Engr., Charles J. Besser Co., Charlotte, N. C.
BUSH, RICHARD J., Asst. Chief, Air Cond. Div., Abbott, Merkt & Co., New York, N. Y.

CAUGHMAN, RICHARD B., Airtemp Tech., Export Div., Chrysler Corp., Detroit, Mich.
CHAPMAN, WILLIAM P., Engr., National Tube Co., Pittsburgh, Pa.

ELLSBERRY, SAMUEL A., JR., Sales Asst., Westinghouse Electric Corp., Sturtevant Div., Dallas, Tex.

GRUENBERG, SANFORD B., Htg., Vent. & Air Cond. Design, R. W. Evans, Minneapolis, Minn.

HAYES, CHARLES R., JR., Mech. Draftsman, Coston & Frankfurt, Oklahoma City, Okla.
HOWES, L. KNOWLTON, Engr., Consolidated Conditioning Corp., New York, N. Y.

KELLER, DWIGHT L., Automatic Heat Co., Decatur, Ill.

LANE, CLARENCE W., Asst. Sales Engr., York Corp., New Orleans, La.
LEMMEN, REESE N., Draftsman, Giffels & Vallet, Inc., Detroit, Mich.

MARTIN, THOMAS I., JR., Asst. to Product Mgr., Insulation Div., Reynolds Metals Co., Richmond, Va.
MAY, CHARLES O., Instructor, David Ranken Jr. School of Mechanical Trades, St. Louis, Mo.

PISKE, RICHARD A., JR., Jr. Engr., Carrier Corp., Atlanta, Ga.

RUBIN, SAUL, Research Engr., La-Del Div., Joy Manufacturing Co., New Philadelphia, Ohio.

SCHOONOVER, WILLIAM A., Sales Engr., The Trane Co., Cincinnati, Ohio.

VANDERVOORT, ROBERT B., East Lansing, Mich.

Student Members

AMMONS, STARON E., Student, Texas A & M College, College Station, Tex.
ARMISTEAD, WILLIAM C., JR., Student, Vanderbilt University, Nashville, Tenn.

CLARK, JOE RICHARD, Student, Texas A & M College, College Station, Tex.
CRAWFORD, DAVID H., Student, Texas A & M College, College Station, Tex.

GOODE, RAYMOND K., Student, Tulane University, New Orleans, La.

HALL, ROBERT E., Student, University of Oklahoma, Norman, Okla.
HALSTEAD, WILLIAM R., Student, Georgia School of Technology, Atlanta, Ga.
HAMMELEN, LUIS P., Student, National University of Mexico, Mexico, D. F.
HAMMETT, LEWIS D., Student, Texas A & M College, College Station, Tex.
HENDON, DANIEL C., Student, Texas A & M College, College Station, Tex.

LAYTON, ROBERT E., JR., Student, Texas A & M College, College Station, Tex.
LEBMAN, FRANK M., Student, Washington University, St. Louis, Mo.
LENTZ, THOMAS H., Student, Texas A. & M. College, College Station, Tex.
LETSOS, JAMES N., JR., Student, Texas A & M College, College Station, Tex.

McMILLAN, HUGH D., JR., Student, Texas A & M College, College Station, Tex.
MORRIS, WALTER K., Student, Texas A & M College, College Station, Tex.
MUNN, WALTER B., Student, Texas A & M College, College Station, Tex.

RUDOLFF, CHARLES S., Student, Texas A & M College, College Station, Tex.

SANFORD, EDWARD H., Student, Tulane University, New Orleans, La.

UHLEMEYER, WILLIAM M., Student, David Ranken Jr. School of Mechanical Trades, St. Louis, Mo.

YOUNG, GLENN R., Student, Texas A & M College, College Station, Tex.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

JOURNAL SECTION

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New York	W. A. Sherbrooke	M. C. Giannini
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Northern Ohio	John James	W. R. Moore
Oklahoma	W. W. Frankfurt	J. H. Spaan, Jr.
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St. Louis	G. W. F. Myers	B. L. Evans
South Texas	C. C. Quin	D. M. Mills
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Southwest Texas	R. W. Barnes	
Utah	E. J. Watts	C. E. Murdock
Virginia	R. C. Thomas	W. H. Webster, Jr.
Washington, D. C.	F. A. Leser	L. B. Nye, Jr.
Western Michigan	C. H. Pesterfield	H. R. Limbacher
Western New York	G. E. Adema	E. J. Woolcock
Wisconsin	F. J. Nunlist	J. R. Vernon

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F. Paul Anderson Award—G. L. Tuve, *Chairman;* C. M. Ashley, F. E. Giesecke, F. C. McIntosh, D. W. Nelson.

Guide Publication—R. S. Dill, *Chairman;* R. L. Byers, R. P. Cook, R. C. Cross, B. H. Jennings, C. F. Kayan, W. M. Wallace, II, W. N. Witheridge, C. P. Yaglou, Cyril Tasker, *Ex-Officio.*

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Publication—J. C. Fitts, *Chairman;* John A. Goff *(two years)*, John James *(three years)*.

To Cooperate with Other Professional Societies—G. D. Winans, *Chairman;* James Holt, A. P. Kratz.

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ASHVE Research Laboratory, 7218 Euclid Ave., Cleveland 3, Ohio
(Tel.: EXpress 6161)

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*Member of Committee on Research.

Officers of Local Chapters

Atlanta: Organized, 1937. Headquarters, Atlanta, Ga. Meets, First Monday. President, H. King McCain, 615 Trust Co. of Georgia Bldg. Secretary, Leo Sudderth, Jr., 306 Bona Allen Bldg., Atlanta 3.

●

Central New York: Organized, 1944. Headquarters, Syracuse, N. Y. President, H. G. Strong, 300 S. Geddes St., Syracuse 1. Secretary, G. F. Keane, 316 Haddonfield Dr., DeWitt, N. Y.

Central Ohio: Organized, 1944. Headquarters, Columbus, Ohio. Meets, Third Monday. President, R. B. Breneman, 1282 Edgehill Rd., Columbus 8. Secretary, A. E. Norman, Jr., 1150 Chesapeake Ave., Columbus.

Cincinnati: Organized, 1932. Headquarters, Cincinnati, Ohio. Meets, First Tuesday, President, H. K. Jennings, 1639 Union Trust Bldg., Cincinnati 2. Secretary, K. B. Little, 832 Temple Bar Bldg., Cincinnati 2.

Connecticut: Organized, 1940. Headquarters, New Haven, Conn. President, S. R. Osborne, Waterbury 91. Secretary, Winfield Roeder, 405 Temple St., New Haven.

●

Delta: Organized, 1939. Headquarters, New Orleans, La. Meets, Second Tuesday. President, J. S. Burke, 317 Baronne St., New Orleans 9. Secretary, R. B. Guest, 827 Dryades St., New Orleans 13.

●

Golden Gate: Organized, 1937. Headquarters. San Francisco, Calif. Meets, First Wednesday. President, F. W. Kolb, 598 Monadnock Bldg., San Francisco 5. Secretary, K. F. Baldwin, Jr., 419 Kentucky Ave., Berkeley 7.

●

Illinois: Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, W. A. Kuechenberg, 1714 Sheffield Ave., Chicago 14. Secretary, G. W. Bornquist, 629 W. Washington Blvd., Chicago 6.

Indiana: Organized, 1943. Headquarters, Indianapolis, Ind. Meets, Fourth Friday. President, I. W. Cotton, 1035 N. Pennsylvania St., Indianapolis 4. Secretary W. R. Fenstermaker, 215 E. New York St., Indianapolis.

Iowa: Organized, 1940. Headquarters, Des Moines, Ia. Meets, Second Tuesday. President, C. A. Wheeler, 1217 Grand Ave., Des Moines. Secretary, D. E. Wells, 701 42nd St., Des Moines 12.

●

Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets, First Monday. President, S. L. Furber, 7429 Forest Ave., Kansas City 5. Secretary, H. E. Gould, 1800 Baltimore, Kansas City 8.

●

Manitoba: Organized, 1935. Headquarters, Winnipeg, Man., Canada. Meets, Third Thursday. President, D. S. Swain, 1186 Downing St., Winnipeg. Secretary, A. W. Moss, 26 Ferndale Ave., Norwood, Manitoba.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, P. A. Croney, 72 Arlington St., Newton. Secretary, R. T. Kern, 51 Clafin St., Leominster.

Memphis: Organized, 1944. Headquarters, Memphis, Tenn. Meets, First Monday. President, N. C. Ledbetter, 22 S. Cooper St., Memphis 4. Secretary, A. T. Bevil, 1521 Waverly Ave., Memphis 6.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, A. E. Knibb, 1003 Maryland Ave., Detroit 30. Secretary, L. A. Burch, 5853 Hamilton Ave., Detroit 2.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, L. C. Gross, 5324 Oaklawn Ave., Minneapolis 10. Secretary, L. J. Krause, 2753 4th Avenue S., Minneapolis 8.

Montreal: Organized, 1936. Headquarters, Montreal, Que., Canada. Meets, Third Monday. President, T. H. Worthington, 405 Beaubien St. W., Montreal, Que. Secretary, S. W. Salter, 910 New Birks Bldg., Montreal.

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Nebraska: Organized, 1940. Headquarters, Omaha, Neb. Meets, Second Tuesday. President, Verne Simmonds, 2416 Vane St., Omaha. Secretary, G. W. Colburn, 106 N. 15th St., Omaha 2.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, M. C. Giannini, New York University, New York 53. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, C. Z. Adams, 312 Piedmont Bldg., P. O. Box 1356, Greensboro. Secretary, M. F. DuChateau, 205 S. Lyndon St., Greensboro.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, C. R. Gardner, 1000 St. Louis St., Dallas 1. Secretary, G. A. Linskie, 3124 Milton St., Dallas 5.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, Ohio. Meets, Second Monday. President, John James, 3170 W. 106th St., Cleveland 11. Secretary, W. M. Rowe, 1302 Swetland Bldg., Cleveland 15.

●

Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, W. W. Frankfurt, 519 Apco Tower, Oklahoma City. Secretary, J. H. Spaan, Jr., 1303 N. Klein, Oklahoma City 6.

Ontario: Organized, 1922. Headquarters, Toronto, Ont., Canada. Meets, First Monday. President D. A. Stott, 195 Spadina Ave., Toronto. Secretary, H. R. Roth, 57 Bloor St., W., Toronto. Ont.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, C. W. Brissenden, Electric Bldg., Portland 5. Secretary, L. G. Williams, Box 304, Gladstone.

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Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, E. H. Langdon, Vine St., Seattle. Secretary, E. J. Rosen, 10238 18th Ave., S. W., Seattle 66.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, E. H. Dafter, 12 S. 12th St., Philadelphia 7. Secretary, L. A. Childs, 330 Harrison Ave., Glenside, Pa.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, D. W. Loucks, 435 Sixth Ave., Pittsburgh 19. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

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Rocky Mountain: Organized, 1944. Headquarters, Denver, Colo. Meets, First Wednesday. President, J. F. Mohan, 2229 Blake St., Denver 2. Secretary, H. C. Kugeler, 2365 Ash St., Denver 7.

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St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, J. H. Carter, 710 Kew West Ave., Webster Groves 19. Secretary, J. S. Rosebrough, 1014 Arcade Bldg., St. Louis 1.

South Texas: Organized, 1938. Headquarters, Houston, Tex. Meets, Third Friday. President, D. M. Mills, Gray and Crawford, Houston 3. Secretary, L. L. Ladewig, Box 1188, Houston 1.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, R. A. Lowe, 6381 Hollywood Blvd., Los Angeles 28. Secretary, John L. Blake, 1700 S. Bedford St., Los Angeles 35.

Southwest Texas: Organized, 1946. Headquarters, San Antonio, Tex. President, F. C. Benham, Jr., 702 S. Flores St., San Antonio. Secretary, L. S. Pawkett, 810 Insurance Bldg., San Antonio 5, Tex.

●

Utah: Organized, 1944. Headquarters, Salt Lake City, Utah. Meets, First Wednesday. President, E. V. Gritton, 2470 S. 15th. Salt Lake City 5. Secretary, C. E. Ferguson, 838 Garfield Ave., Salt Lake City.

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Virginia: Organized, 1946. Headquarters, Norfolk, Va. President, R. C. Thomas, 819 Westover Ave., Norfolk 7. Secretary, J. F. Reynolds, Gatling and Marble Ave., Norfolk 2.

●

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, H. H. Hill, 438 Woodward Bldg., Washington 5. Secretary, J. G. Muirheid, 2013 New Hampshire Ave., N. W., Washington 9, D. C.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, Frank Harbin, Jr., 280 E. 6th St., Holland. Secretary, W. C. DeRoo, 500 E. 8th St., Holland.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, G. E. Adema, 39 W. Balcom St., Buffalo 9. Secretary, J. H. Bryce, 88 E. Girard Blvd., Kenmore.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, M. W. Bishop, 228 N. La Salle St. (Chicago 1, Ill.). Secretary, B. M. Kluge, 1817 S. 66th St., Milwaukee 14.

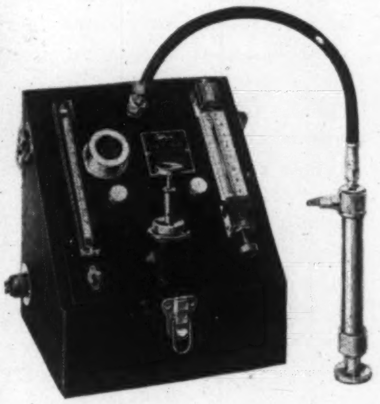
Student Branch

Texas A. & M. College: Organized, 1946. Headquarters, College Station, Tex. Meets, Third Thursday. President, G. H. Jackson, 225 W. Nevada St., El Paso. Secretary T. V. Burns, 2307 Driscoll, Houston 6.

EQUIPMENT DEVELOPMENTS

For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January 1947 Heating, Piping & Air Conditioning and thus keep your records of sources of supply up to date throughout the year. Single asterisk indicates equipment not listed in Directory Section; double asterisk equipment and manufacturer not listed.

Measures Dew Point from Fog in the Air



No. 3512* — The new "Alnor Dewpointer" is an instrument for quickly measuring dew point and it is based on the principle of observing dew or fog suspended in the air. The manufacturer is Illinois Testing Laboratories, Inc., 420 N. La Salle St., Chicago 10, Ill.

The unit, said to be simple and compact, is designed to provide ease and accuracy in measuring humidity so that two or more observers may obtain the same result. The unit is available in two ranges; for dew points from —20 F to room temperature and from —100 F to 0 F.

Centrifugal Refrigeration Compressor Uses Propane

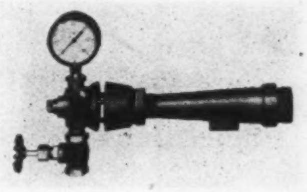
No. 3513—A successful run-in test of the first centrifugal compressor to use propane in a refrigeration cycle—said to open a new field of possibilities for the world's oil refineries—has been reported by the Carrier Corp., 302 S. Geddes St., Syracuse 1, N. Y.

Set up as a self-contained, complete package, including compressor and turbine, as well as auxiliary oil pumps and oil coolers, the new unit covers a floor area only 5 ft x 15 ft. Company spokesmen reported the unit affords great space saving and lower original and maintenance costs. The refrigerant, propane, is an inexpensive byproduct readily available in all refineries.

The first unit will be installed by the Atlantic Refining Co. in its new Point Breeze, Pa., plant by E. B. Badger & Sons Co., Boston contractors. Atlantic will use the machine in its dewaxing process, in which oil is chilled to approximately —25 F in order to congeal and remove the wax base.

Other gas compressors in this line range in capacity from 1000 to 30,000 cfm. The smaller size units can be furnished with three, four or five impellers on one shaft. The larger units can be furnished with three or four impellers on one shaft. Both large and small units are designed to operate below the first critical speed. Units are designed to handle up to 8500 hp in a single casing and are adaptable to any temperature level from –150 up to 100 or 150 F inlet temperature. The pressure range is from extremely high vacuum up to inlet pressures of from 100 to 200 psi.

Improves Venturi Mixer for High Pressure Gases



No. 3514 — Production of a "Hijector" venturi mixer for high pressure gases, incorporating improved mechanical design features, has been announced by the Industrial Division, Bryant Heater Co., Cleveland, Ohio.

The new unit uses gas under pressures up to 35 psi to entrain air needed for combustion and to deliver the mixture to burners at high pressure. Overall length of the unit is substantially reduced over conventional designs by rearrangement of the elements for ease of servicing; and by reversing the usual operation of the air shutter and locating it on the body, the orifice spud is accessible for removal without disconnecting any piping, according to the manufacturer.

Available in pipe sizes from ¾ to 4 in., the unit is designed for use with all types of gases, including liquefied petroleum types. Capacity tables for gases ranging from 500 to 2500 Btu are available.

Aircell Asbestos and Aluminum Foil Combined in Insulation

No. 3515—Thermal insulation material consisting of a layer of aluminum foil laminated to ¼ in. single ply aircell asbestos is offered by Alfol Insulation Co., 155 E. 44th St., New York, N.Y. Said to be durable and light weight, it is offered for high temperature applications such as ovens, boilers, boiler jackets, furnace casings, hot water heaters, radiator enclosures, pipe insulation, etc.

The aluminum foil is said to reflect 95 per cent of the radiant heat striking it and, according to the company, the insulating effect of the combined ¼ in.

Heating, Piping & Air Conditioning **[8-47]**
6 N. Michigan Ave., Chicago 2, Ill.

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in Equipment Developments and Recent Trade Literature.

(Circle each number in which you are interested)

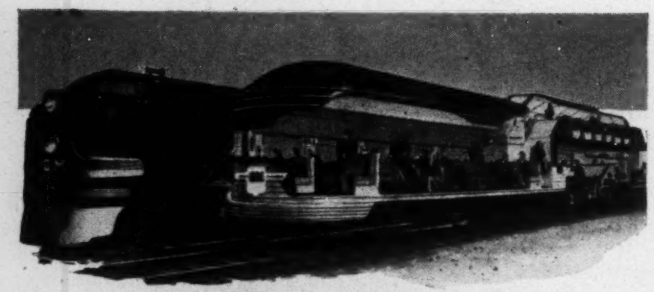
3512 3513 3514 3515 3516 3517 3518 3519 3520 3521
3522 3523 3524 3525 3526 3527 3528
6589 6590 6591 6592 6593 6594 6595 6596 6597 6598
6599 6600 6601 6602 6603 6604 6605 6606 6607 6608
6609 6610 6611 6612 6613 6614 6615 6616 6617 6618
6619 6620 6621

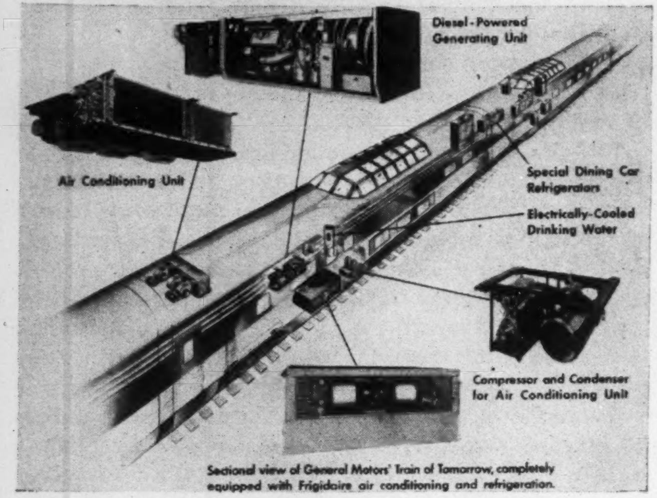
Name............................ **Title**...............

Company...

Address...

City..................... **Zone**...... **State**...............





Diesel-Powered Generating Unit
Air Conditioning Unit
Special Dining Car Refrigerators
Electrically-Cooled Drinking Water
Compressor and Condenser for Air Conditioning Unit

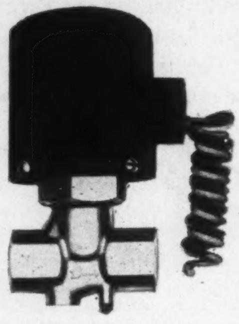
Sectional view of General Motors' Train of Tomorrow, completely equipped with Frigidaire air conditioning and refrigeration.

DEPENDABLE VALVES DO THEIR PART ON

General Motors' Thrilling

Train of Tomorrow

Railroad travelers for years to come will praise the magnificent effort of General Motors Corporation in creating this newest word in traveling comfort and pleasure. For the amazing Train of Tomorrow is smoother-riding, has more restful roomy chairs, the sleeping comfort is increased, you dine in a roof-garden setting and ride in complete air conditioned comfort. All these and more make the Train of Tomorrow a truly remarkable achievement in vacation or business travel . . . a thrill to see today . . . a joy to experience tomorrow.



A-P 73RJ Refrigerant Solenoids—popular with Air Conditioning and Refrigeration Engineers — are doing their part on General Motors Thrilling Train of Tomorrow.

And A-P Dependable Refrigeration Valves are standard equipment on this fine new train. Just as A-P contributed to human comfort in the *first air conditioned streamliners* to race over the rails years ago, so A-P Valves again contribute to comfort in the new Train of Tomorrow.

AUTOMATIC PRODUCTS COMPANY
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Export Dept., 13 East 40th St., New York 16, N. Y.

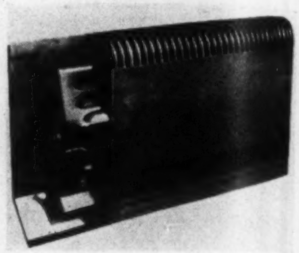
DEPENDABLE *Refrigerant Valves*

Stocked and Sold By Good Refrigeration Wholesalers Everywhere
Recommended and Installed By Leading Refrigeration Service Engineers

aircell asbestos and aluminum foil is equal to a 1 in. thickness of plain aircell asbestos. The material is supplied in 36 in. width rolls of 250 sq ft each with each roll weighing about 40 lbs. The material is flexible so that it can be rolled, shaped, and cut for many applications.

Special cut sizes are available to order, and ½ in. and 1 in. thick rigid asbestos aircell board is also available for special applications.

Baseboard Radiation Has Aluminum Fins

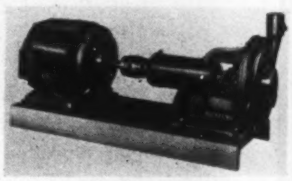


No. 3516—The "Convect-O-Base" baseboard radiation panel, consisting of a panel cover and aluminum fins which are clamped to 1 in. pipe, is offered by the Minimite Co., 623 S. Kildare Ave., Chicago 24, Ill.**

The slotted fins are of 0.032 in. thick aluminum and are clamped with a special fastener above and below the pipe as shown here. Total height of the fins is approximately 7 in. and the cover panel is about 8 in. high, projecting from the wall 2 in.

Unusual features are said to include exceptionally large heat output per foot of panel and great flexibility. The fin sections are made in 12 in. lengths and may be installed as necessary to provide proper heat distribution. The cover sections are offered in lengths of 6 ft., and in addition, special corner pieces and end stops can be used for fitting the panel to room dimensions.

Standardizes Line of Side Suction Centrifugal Pumps



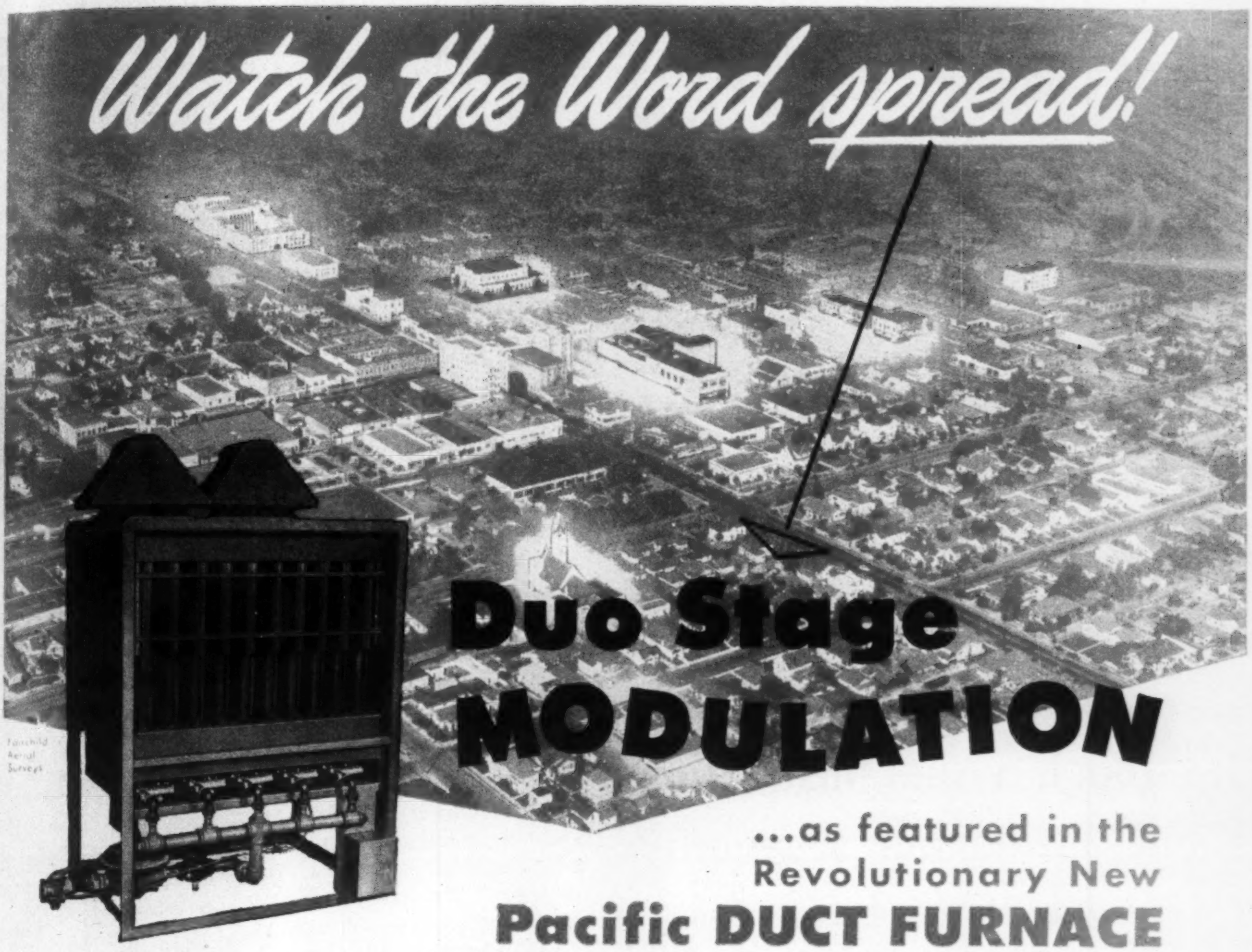
No. 3517—Designed to meet a wide scope of pumping requirements in diversified industries, a new line of standardized side suction centrifugal pumps has been announced by the Deming Co., 14 Aetna St., Salem, Ohio.

The pumps are made in three types—single ball bearing with open type impeller, two ball bearing with open type impeller, and two ball bearing with semi-enclosed impeller. Each of the three types of pumps is made for belt drive and for direct connection to an electric motor.

The complete line includes five sizes, ½, ¾, 1, 1½, and 2 in. side suction. Capacities range from 2 to 200 gpm.

Improved Speed Selector Provides Infinite Ratios

No. 3518—A new, improved infinite ratio speed selector, designed as an independently mounted transmission, has been jointly announced by Speed Selector, Inc., Cleveland, and the B. F. Goodrich Co., Akron, Ohio.



Watch the Word spread!

Duo Stage MODULATION

...as featured in the Revolutionary New

Pacific DUCT FURNACE

The most exciting development in Automatic Gas Heating in years! That's the new Pacific Duct Furnace with the unique Duo Stage Modulation.

Ideal for so many types of larger buildings—schools, churches, theatres, residences, stores—the Duct Furnace is a highly efficient component of your heating, ventilating or air conditioning system, to which a still greater flexibility has been added.

By automatic selection of two stages of discharge air temperature, Duo Stage Modulation permits maintenance of constant room temperature without diminishing warm air circulation or fresh air ventilation.

This new conception of "heat blending" materially reduces stratification, temperature fluctuation and gas consumption. It also assures a wholly new standard of sustained comfort throughout the building being served.

Gas heating authorities everywhere make no bones about it. This new furnace is exciting news! It is the practical, immediate successor to conventional "hot blast" forced air furnaces.

Up and down every street in your town are customers who await the new Pacific Duct Furnace.

PATENT APPLIED FOR
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MORE EXCITING NEWS TO COME
Pacific is the company to watch...other "Front Page News" will soon be announced to the Gas Heating Industry.
34 YEARS IN GAS HEATING EXCLUSIVELY!

MANUFACTURING CO.
PACIFIC
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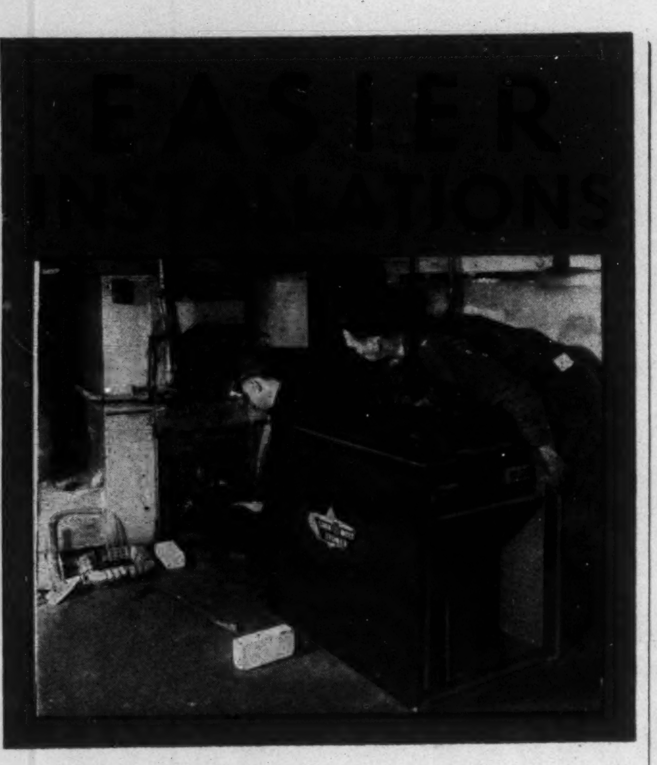
NACO MANUFACTURING CO.
PACIFIC HEATER DIVISION
P. O. BOX 310 • HUNTINGTON PARK, CALIFORNIA



through visual instruction and mechanical superiority

In the stoker business, the dealer's selling price is largely determined by competition, but the profits are determined on cost of selling. Link-Belt mechanical superiority means satisfied customers (who tell their friends) and provides effective talking points for the dealer.

One of the many effective merchandising and engineering helps developed by Link-Belt this year is a series of films on installation and service. The illustration shows one of the panels. Let us tell you more about our dealer and distributor proposition.

LINK-BELT COMPANY, ***Stoker Division***
2410 W. 18th St., Chicago 8, Illinois

Send data to______________________________

____
10,722

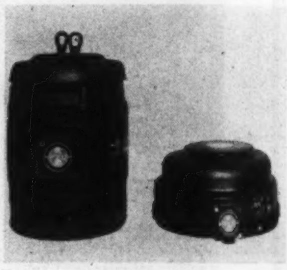
LINK-BELT
Magic Flame and Power-Flex STOKERS

The unit employs planetary motion with four variable pitch sheaves and two standard cross section v belts to provide any speed from zero to 800 rpm at constant torque, from a constant speed power source. The multiplying action of the planetary converts a slight change in sheave pitch diameter to a wide change in output speed. The high and nearly constant belt speeds are said to permit almost instantaneous changes in output speed by the lever action self-locking control handle.

Available in ½, 1, and 2 hp output, the selector has cast iron sheaves on hardened and ground shafts and guide pins with heated prelubricated ball bearings mounted in cast aluminum housings. Optional v belts or flexible coupling input and output is designed to make the unit adaptable for mounting in any position on new or existing equipment such as agitators, conveyors, cookers, dryers, hoists, machine tools, mixers, process machinery, plastic machinery, and pumps.

Major advantages claimed are: infinite ratio, quick speed changes, smooth operation, high efficiency, adaptability, simplicity, pre-selection of speeds, and ease of installation.

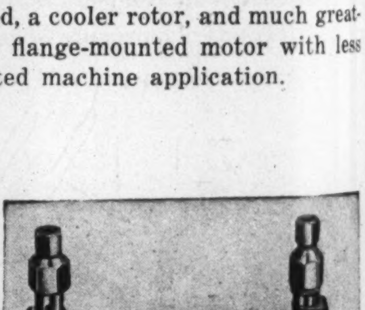
New Operating Principle Used in Electric Motor



No. 3519—Fairbanks, Morse & Co., Chicago, have introduced a new type of electric motor designated as "Axial Air-Gap." Principles of this motor are said to be revolutionary in that the magnetic lines of force follow a path parallel to the shaft (or axis of rotation) as compared to a radial path taken by the magnetic flux in the so-called conventional motor.

This new line of motors, ranging in size from ⅓ to 10 hp, is suitable for horizontal or vertical flange mounting or on an angle base for belt drive. Outstanding features are said to include space and weight reduction (the new motor being less than half the size of the conventional type motor and weighing less by approximately 30 per cent), improved appearance, the simplicity and speed with which it can be inspected, cleaned and lubricated, a cooler rotor, and much greater acceptability as a flange-mounted motor with less overhang for unlimited machine application.

Humidifier Is Air Operated



No. 3520—The "Atomick" humidifier, offered by Maid-O-Mist, Inc., 3218 N. Pulaski Rd., Chicago, Ill., is designed to be a simple, inexpensive device for adding humidity to indoor atmospheres. It is

offered particularly to those industries where proper humidity is vital, but it may also be used for atomizing liquid insecticides such as DDT or any other liquid which will flow readily through pipes.

The device is air operated. Where a compressed air line is not available, a small compressor, such as artists use, may be employed. The single spray unit is said to atomize up to 1¼ gph, while the four spray unit will handle four times as much. According to the manufacturer, it can be applied in conjunction with any type of unit heater or may be used independently where direct radiation or warm air furnaces are installed.

When used with unit heaters, the device may be controlled so as to deliver a mist of water vapor into the air stream whenever the heater is in operation, or it may be controlled separately.

More Moisture Removed from Refrigerant

No. 3521—Extensive research, together with the installation of additional manufacturing equipment, now makes possible "Freon" refrigerants containing less than 10 parts per million of moisture, according to the manufacturer, Kinetic Chemicals, Inc., Wilmington 98, Del.

To determine the moisture content, a new specification method was developed. This utilizes a spectrophotometer in which moisture-absorbing infrared beams are passed through samples of the refrigerant. The instrument is said to measure the water present with an accuracy of one part per million and to permit both control and production of the finished product.

Detects and Locates Leaks in Vacuum Systems

No. 3522—Davis Emergency Equipment Co., 201 Halleck St., Newark 4, N. J., has developed a new instrument for the detection and location of leaks in vacuum systems. The unit is said to embody features which render the use of complicated devices and procedures unnecessary as it eliminates the need for shutting down vacuum systems in order to detect a leak.

A heated wire, housed in a metal chamber, is part of a wheatstone bridge circuit. When a vacuum is pulled on the chamber, the filament becomes slightly chilled, upsetting the balance of the wheatstone bridge and causing a needle to rise on the scale of the meter. It is claimed that this instrument is extremely sensitive, registering a leak as small as the equivalent of 0.006 in. water, which causes a ⅛ in. deflection of the needle on the scale. It is claimed further that the device can be used equally well in the detection of leaks when checking welded seams or joints on equipment under pressure.

Frick Ammonia Compressors Serving a Large Hospital

Frick Freon-12 Compressors Air Condition an Office Building

Whether You Need Ammonia or Freon-12 Equipment, You Get What You Want with

TRADE FRICK MARK Refrigeration

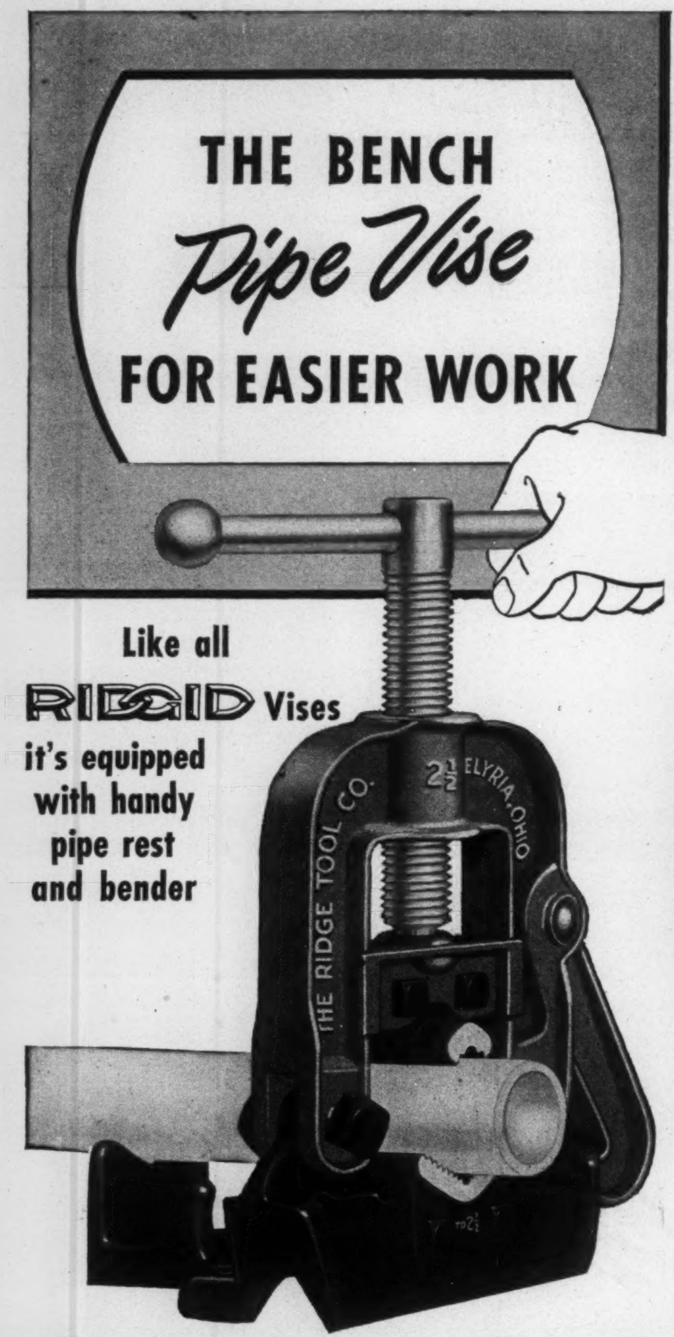
As builders of both ammonia and low-pressure systems, we are in an unbiased position in filling your requirements.

For the ultimate in satisfactory cooling equipment, put your problems up to the nearest Frick Branch or Distributor.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK Co.
WAYNESBORO, PENNA. U.S.A.

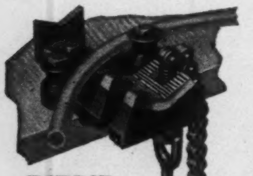
Frick Ammonia Compressor

Frick Freon-12 Compressor



Like all RIDGID Vises it's equipped with handy pipe rest and bender

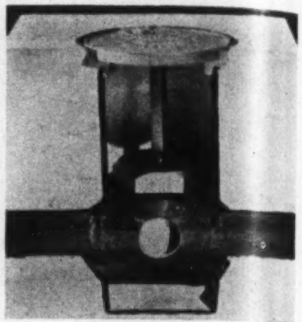
● Extra features that save you work make this RIDGID bench yoke vise more for your money. An integral pipe rest, a bender that won't flatten pipe, LonGrip jaws that protect polished pipe. Years of trouble-free service—special malleable frame and heat-treated tool-steel jaws for maximum wear. Eight sizes for pipe to 6 inches—look for the RIDGID red-top at your Supply House.



RIDGID
chain type vises in 5 sizes to 8."

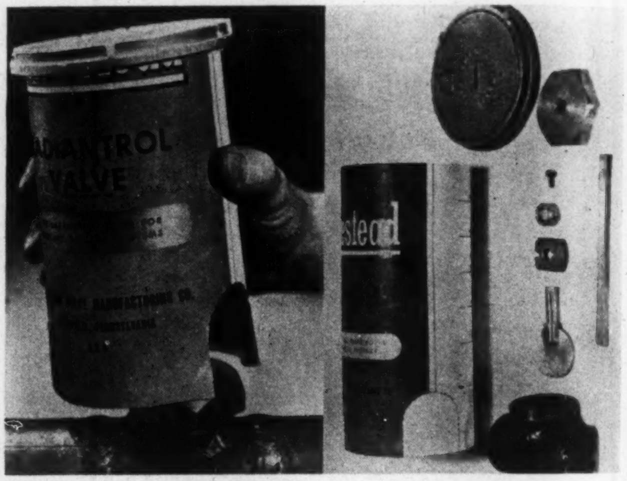
RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL COMPANY • ELYRIA, OHIO

Designs Valve for Venting, Balancing Radiant Systems



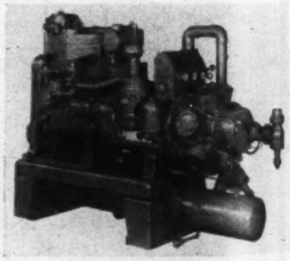
No. 3523*—A unique valve called the "Radiantrol" is being offered by Homestead Valve Mfg. Co., P. O. Box 348, Coraopolis, Pa., for balancing and venting radiant panel heating systems. The unit is similar to a butterfly type control valve and can be used with pipe coils buried as deep as 8 in. below a concrete surface.

The hollow brass control stem, which can be cut to appropriate length, extends from the valve to a brass floor plate 3⅝ in. in diameter. The plate fits flush with the concrete floor and can be operated by foot. However, a slightly different model is offered for hand operation, in which case the valve is located in a pit or off the floor in a cupboard, etc.



The valve disc is built into a wrought iron body made of a short piece of pipe end-beveled to facilitate welding into a section of the heating coil. Venting is accomplished by removing the floor plate and hollow stem and by turning a small cap screw on top of the valve bonnet which is drilled to permit the escape of air. The fiber container, in which the valve is shipped, is designed so that it may be used as a concrete pouring form. The unit is made in 1¼ in. size for use with 1 and 1¼ in. pipe.

Refrigeration Units Driven by Engine



No. 3524**—The Ready-Power Co., Detroit 14, Mich., has developed a line of engine-driven compressors and condensing units for "Freon-12" combining radial compressors with industrial engines for operation on gasoline, natural gas, butane, kerosene, or diesel fuel. Capacities are 15, 25, and 35 tons at 40 F evaporator temperature.

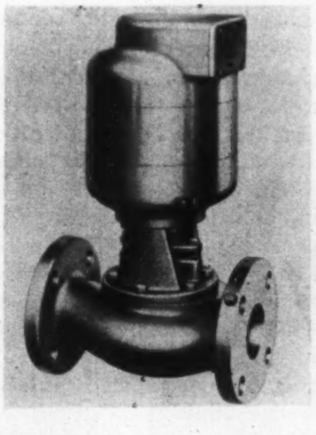
Designed for stationary, portable, and marine installations where three phase current is not available, these units are designed to permit the use of the lowest priced fuel locally available and are said to provide substantial operating savings. Radial compressors, unloaded for starting, are direct-connected to industrial type engines without the use of clutches or belts. Alignment, independent of the base, is obtained by a three point flexible mounting of engine-compressor assembly. Vibration isolation units are integral, and residential type exhaust silencers and engine cooling heat exchangers, utilizing condenser waste water, are used. Automatic operating controls are said to provide continuous capacity control through a range of 15-100 per cent of rated capacity by maintaining constant suction pressure under varying load conditions.

Air Filters Packaged in Paper Bags

No. 3525—The sale of replacement air filters in durable paper bags is a packaging idea introduced by the Research Products Corp. of Madison, Wis., manufacturers of "Self-Seal" air filters, which can now be purchased by dealers in packages containing two or three filters of the commonly used sizes.

The cost of the new packaged filters is said to be only slightly higher, and the wrapping problem is eliminated. The bag is covered with scatter printing in a design illustrating the enclosed product and is processed with a glazed liner designed to prevent absorption of the filter adhesive by the wrapper.

Totally Enclosed Motor Used on Circulating Pump



No. 3526—The "Rumaco" circulating pump, Model 1-B, has been developed by Ruthman Machinery Co., Cincinnati 2, Ohio, primarily for hot water heating systems in both residential and industrial applications. The driving motor, direct connected to the pump, is a totally enclosed type equipped with grease-packed, sealed ball bearings. Lubrication fittings have been eliminated as no added lubrication is necessary.

The centrifugal pump is provided with opposed inlet and outlet for standard 125 psi, 2 in. pipe flanges. According to the manufacturer, the unit can be installed in pipe lines of various sizes by using reducers and can be operated in any intermediate angle between the vertical and horizontal position.

CLEAN Pipe Threading WITH LESS WORK

RIDGID No. 1 R Poster Threader offers you new easy speed threading 1" to 2" pipe

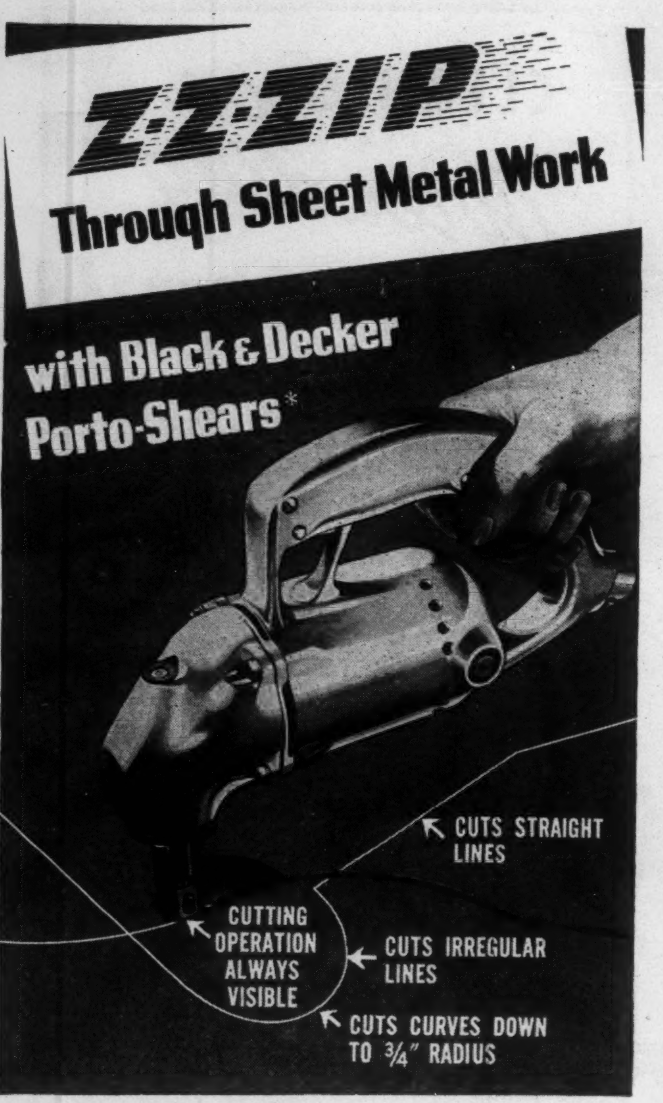
Stands up handily on its own feet.

● If you prefer a poster die stock, you'll prefer this 1R—it short-cuts some of the get-ready most posters require. 1" to 2" dies change quickly as any, but mistake-proof workholder sets to pipe size almost instantly—only 1 screw to tighten on pipe and no bushings to fool with. Threading action is direct, free of wabble. Durable steel-and-malleable construction. Popular price. Buy at your Supply House.

RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY • ELYRIA, OHIO



Black & Decker Electric Porto-Shears cut sheet metal too tough for snips, speed up jobs where snips are slow. Fast, powerful shearing action eliminates hard muscular strain. Easy to follow patterns because cutting operation is always visible. B & D 16-Gage Porto-Shears cut up to rated capacity in steel or galvanized iron; about one gage thinner in Monel or stainless; 50% above rating in copper, aluminum, lead and other non-ferrous metals.

For full information on cost-cutting Porto-Shears . . . and other Electric Tools for heating, piping and air conditioning work . . . see your nearby Black & Decker Distributor. For your free copy of our complete catalog, write to: The Black & Decker Mfg. Co., 628 Pennsylvania Ave., Towson 4, Maryland.

*Trade Mark Reg. U. S. Pat. Off.

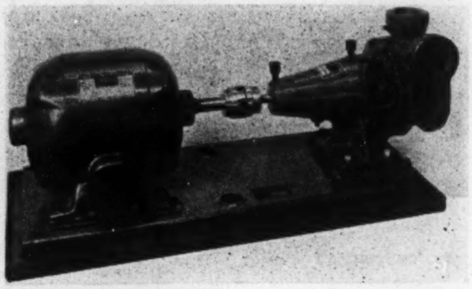
LEADING DISTRIBUTORS EVERYWHERE SELL

Black & Decker

PORTABLE ELECTRIC TOOLS

Turbine Pump Designed For Any Clean Liquid

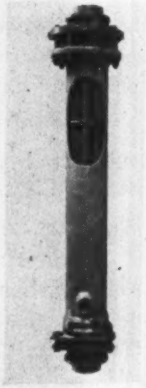
No. 3527—Walter H. Eagan Co., 2336-38 Fairmount Ave., Philadelphia, Pa., has announced a new line of turbine pumps designed to handle all clean liquids up to 500 SSU viscosity and for capacities up to 250 gpm and pressures up to 200 psi.



All units can be furnished with primers and are said to develop suction lifts up to 28 ft. According to the company, the pump has been designed to operate at high heads while at relatively low capacity; to provide high efficiencies, low speeds, and reduction in power on drop in head; and to handle nonlubricating fluids at high temperatures.

Applications for these units, which have only one rotating element and which incorporate self-priming features, are said to include booster service, condensate return, brine circulation, gasoline transfer, boiler feed service, hot water circulating, and air conditioning units.

Heat Exchangers Designed for Corrosive Conditions



No. 3528—Seven tube "Karbate" impervious graphite shell and tube heat exchangers for use under corrosive conditions are now available from National Carbon Co., Inc., 30 E. 42nd St., New York 17, N. Y., in three standard sizes of 4 ft 3 in., 7 ft 3 in., and 10 ft 3 in. length. All three units employ 1 in. ID x 1½ in. OD tubes in bundles encased in standard 6 in. ID steel pipe shells. The exchangers are identical in every respect except for pipe length and the number of baffles, and all tube bundles and shells of the same size are interchangeable.

The units are designed for use as heaters, coolers, boilers, or condensers, and can be operated vertically or horizontally. They will carry temperatures up to 338 F and a working pressure of 50 psi on both the tube and shell sides. Standard nozzle connections are used to permit installation with piping connections of almost any material. Water, brine, or steam are suitable on the shell side—says the manufacturer.

The impervious graphite is said to have high thermal conductivity (three times as high as carbon steel) and resistance to the action of most acids, alkalis, and other corrosive, solvent, or reducing agents—particularly to all concentrations of hydrochloric acid and nearly all concentrations of hot sulphuric, phosphoric, and acetic acids, wet chlorine, and the organic solvents.

Equipment Shorts

"Liquid Envelope," a peelable plastic film for coating paint spray booths, is being manufactured by Better Finishes & Coatings, Inc., 268 Doremus Ave., Newark 5, N.J. The new material is sprayed on the clean booth in a film 0.002 to 0.005 in. thick. When the booth is ready for cleaning, the coating is peeled off carrying with it accumulated paint, lacquer, and spray dust. The manufacturer states that a 6 x 6 ft booth can be stripped clean in less than 5 min and recoated in the same time.

A "Gauge-Faucet" for 55 gallon drums and consisting essentially of a draw-off valve and plastic gage is being offered by C & C Die Casting Co. Inc., 60 South St., Boston, Mass. Designed to eliminate guesswork and yardstick measuring, the unit is located for easy reading while drawing the contents of the drum.

Products of the Bryant Heater Co., of Cleveland, Ohio, are now rolling off the assembly lines of the company's new Tyler, Tex., plant. Full production was obtained almost a year to the day from the time ground was broken. Water heaters, room heaters, panel wall heaters, and floor type furnaces are among the gas-fired equipment being produced at this plant.

A new building for increasing the production of evaporative condensers and floor type unit coolers is being built as an addition to the factory of Acme Industries, Inc. of Jackson, Mich.

The R. B. Rogers Companies, Inc. of New York has moved its air conditioning division to a larger, modern factory at Sanford, N. C. Air conditioning, heating, cooling, and ventilating units, as well as chemical dehumidification equipment and industrial cooling towers will be produced at this Sanford factory of the Edwards Co., a division of Rogers. The sales department and engineering and research laboratory will remain in New York, and there will be no changes in management or personnel.

Kinetic Chemicals, Inc. of Wilmington, Del., is installing equipment at East Chicago, Ind., for the manufacture of "Freon" refrigerants. The new plant is scheduled for operation in the spring of 1948 and will increase the manufacturing capacity by 75 per cent. According to the company, "it is anticipated that there will be an adequate supply of these refrigerants during the busy months of next year."

OHI Plans Convention and Exhibition in Chicago

The Oil-Heat Institute of America, 30 Rockefeller Plaza, New York City, is planning to hold a convention and exhibition of products at the Coliseum in Chicago, the week of April 5, 1948.

Here's why ALDRICH equipment is easy to sell

Advanced design. Exclusive Aldrich features win instant acceptance — build sales.

Low cost operation. Aldrich units are misers on fuel — equally saving of servicing.

Easy installation. Carefully engineered for quick, simple, inexpensive installation.

Less servicing. Simplified design, fewer parts, and rugged construction minimize servicing.

Finer performance. Smooth combustion — more heat per gallon of fuel. Quiet. Dependable.

ALDRICH HEAT-PAK

OIL BURNERS

One burner with efficient firing range of .75 to 5.00 G.P.H.

Exclusive interchangeable draft tube equipment enables one model to efficiently cover extreme firing range. And, three sizes cover the entire range up to 19 G.P.H. Exclusive Aldrich design attains higher CO_2 rating with small fires. Combustion is always smooth. Write today for facts on HEAT-PAK products.

BURNER-BOILER UNITS

Six sizes—up to 3040 square feet E.D.R. steam

"Custom-fitted" Aldrich burner-boiler units synchronize boiler capacity to burner output for real economy. All-steel — extra-heavy, ¼" or more. Fire tube design (no water tubes) avoids clogging under bad water conditions. Seams and flue end easily accessible from outside — repairs easily made if needed.

HEAT-PAK equipment is guaranteed by Aldrich Company — world's largest oil burner manufacturer. Each part is made to work with every other . . . all from one firm. You can depend on Aldrich to be *first* with the *new!*

KNOWN AND USED THE WORLD AROUND

ALDRICH COMPANY — WYOMING, ILLINOIS

EXECUTIVE CHANGES

Kennard Corp., of St. Louis, manufacturer of finned coils and blower units, has announced several changes in its executive group which, according to Sam M. Kennard, III, president, are in preparation for an expansion of the company's line. A. G. Loeffel is the new vice president in charge of sales and development. He entered the refrigeration field in 1916 with the York Corp. and has had wide experience in the industry. He was affiliated with the Marlo Coil Co., of St. Louis, for the last nine years.

F. E. Ince was elected to Kennard's board of directors last January and is now serving as vice president in charge of application and research. L. C. McGowen has been elected to the board and is secretary of the company. He has been in the refrigeration industry since 1933 and served as a naval reserve officer during the war. F. G. Bietsch, who joined the firm in 1942, has also been elected to the board and is currently vice president in charge of accounting.

William Ludvik has returned to the McAlear Mfg. Co., Chicago, as president and general manager, following recent negotiations by him for the acquisition of the entire stock, plant, and equipment of the McAlear division in Chicago from Climax Industries, Inc.

Mr. Ludvik now heads a company with which he has been identified almost from the time it was founded by the late James A. McAlear nearly 30 years ago. For several years prior to 1943, when the organization became a division of Climax, he was vice president and manager.

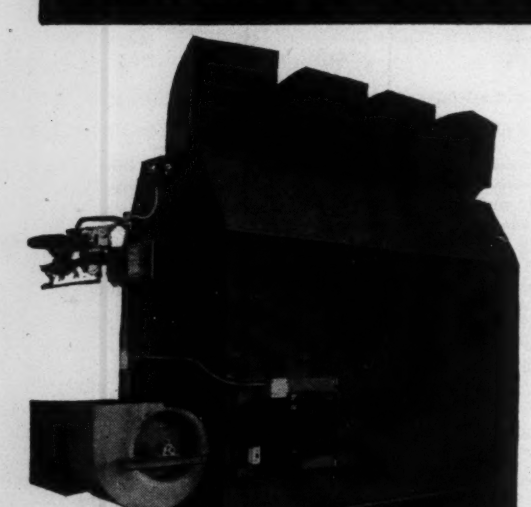
R. T. Jenkins has been promoted to assistant general manager of the Marley Co., Kansas City, manufacturer of cooling towers, nozzles, and other water cooling equipment. L. A. Christensen has been made general sales manager, and R. W. Maze has been appointed public relations director.

The Herman Nelson Corp., Moline, Ill., has announced the appointment of C. W. Trambauer as manager of the company's Detroit branch. He will handle sales of unit heaters, unit ventilators, fans, and blowers.

Norbert Downey has joined the staff of McQuay, Inc., Minneapolis, manufacturers of refrigeration and other air conditioning equipment. He will be in charge of industrial unit heating sales. Mr. Downey is noted in the industry for his unorthodox sales promotion tactics in introducing new products.

AIRTHERM
DIRECT-FIRED
WARM AIR HEATERS

Offer You These Six Heating Advantages



1. A complete factory heating unit.
2. Comes to you ready to set in place.
3. Control system wired at factory.
4. Available in floor-mounted or suspended models.
5. Oil burners or gas burners are interchangeable to meet future fuel conditions.
6. Capacities from 650,000 to 1,950,000 BTU per hour.

For detailed information, write for Bulletin 801-A.

AIRTHERM
MANUFACTURING CO.
711 South Spring Ave. • St. Louis, Mo.

55

NEW BOOKS & REPORTS

Says Any Source of Low Grade Heat Can Be Used for Heat Pump

The present interest in the heat pump is in a large part due to the efforts of Philip Sporn. Therefore, the first book to be published on the subject could be written by none better than by him and his associates, E. R. Ambrose and Theodore Baumeister, professor of mechanical engineering, Columbia University. These men have gained a considerable amount of knowledge on the subject from their experience in designing and installing a number of heat pumps on the properties of the American Gas and Electric Service Corp., of which Mr. Sporn is president. Messrs. Ambrose and Baumeister are air conditioning engineer and consulting engineer, respectively, with that company.

The authors state that "as a result of many years of operating and design experience, they have written this book with the primary purpose of presenting a reasonable technical treatment of the numerous problems encountered in the attempt to adapt the heat pump, not only to building heating and cooling, but also to the important applications in the industrial field."

The subject is treated in the text in an academic manner and covers thermodynamic principles, equipment design, selection and control problems, industrial applications, operating economies, and a description of a few heat pump installations. The following are a few interesting and pertinent statements taken from the book.

"There is no fundamental difference between a conventional refrigeration system and the so-called heat pump system. Thermodynamically both systems are heat pumps employing a compressor, condenser, cooling coils, and expansion valve to absorb heat at a low temperature level and reject it at a higher temperature level."

"The four basic type heat pump systems most commonly employed are (1) air to air, (2) water to air, (3) air to liquid, (4) water to water."

"The climatic conditions, the type of building, the size of building, the temperature to be maintained, and the sources of heat are the prime factors in the design of a suitable heat pump system."

"Any source of low grade heat can be exploited by using the heat pump principle. The coefficient of performance of the heat pump cycle is dependent on the temperature of the medium and is not affected by the type or kind of heat source employed."

"It is to be regretted that in the present stage of heat pump development very little information is available on heat transfer coefficient and other data needed for a proper evaluation of heat sources."

"The ground offers possibilities as a heat source, but to date little factual information is available on the conduction of heat to and from the soil. Several research projects are now under way to investigate the ground as a source of heat and to determine the actual transfer coefficients for different types of soil."

"The equipment and installation cost of a heat pump cannot be directly compared with a conventional heat-

YOU CAN GET IT QUICKER FROM
STEWART

QUICK FACTS ABOUT HIGH VELOCITY OUTLETS MADE BY STEWART

The styles illustrated are typical examples of improvements in the Stewart line of Outlets, Wall and Baseboard Registers, Scoopaires and Radiator Fronts. All have been redesigned for smarter appearance, better diffusion and more flexible adjustment. The Stewart line is competitively priced and includes a wide range of popular types and sizes of outlets for air-conditioning, heating and ventilating. Special types and sizes can be made to your specifications.

PROMPT DELIVERIES ON STANDARD SIZES

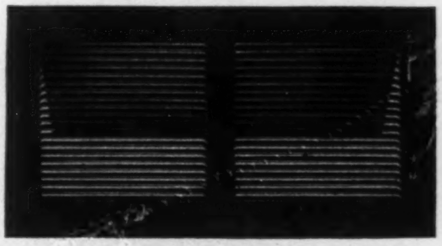
STYLE DDV

(2 Banks)
Individually
Adjustable
Face and
Rear Bars

Style DDV is one of 8 variations of Stewart High Velocity Outlets. By means of a detachable key, all bars are adjustable for directing air straight and at various right-left or up-down angles. Style DDV has vertical face bars and horizontal rear bars. Style DDH (not shown) has horizontal face bars and vertical rear bars. This type of outlet is made in popular sizes with or without lever-operated, multiple volume valves. Matching intakes are available. OUTLETS CAN BE SUPPLIED TO FIT CONTOURS OF CABINETS FOR ROOM COOLERS.

STYLE 91

Lever-operated
Single Damper
Wall Register



STYLE 91 is from the series 70-90 of Wall and Baseboard Registers made with single dampers, or multiple-valve dampers, both lever operated. Face bars of the 90 series are horizontal and set down at a 22 degrees angle. Face bars of the 70 series are vertical, set straight. Setting keys are furnished for user to alter bar settings. Matching, fixed bar grilles are available.

Send for literature and prompt quotation on your requirements

STEWART MANUFACTURING COMPANY
INCORPORATED
610 Bloomfield Avenue
Bloomfield, N. J.

ing system because the heat pump is a year-round air conditioning plant supplying both heating and cooling, whereas the conventional system supplies winter heating only. The heat pump cost should be compared with the cost of a conventional heating system plus that of a conventional cooling system."

It is interesting to note that the authors make repeated reference to the lack of basic information on heat sources. Since at the present time the availability of completely designed heat pumps is limited, the information in this book should be helpful to those interested in installing experimental heat pumps—from which more factual data on heat sources may be obtained.

This book, entitled Heat Pumps, is published by John Wiley & Sons, Inc., 440 4th Ave., New York 16, N. Y., contains 188+vii (5½ x 8½ in.) pp., is cloth-bound, and is priced at $3.75. (Reviewed by G. G. Freyder, air conditioning engineer, Commonwealth Edison Co.)

Revises Standards for Installation of Blowers and Exhaust Systems

The National Board of Fire Underwriters has issued revised standards for the installation of blower and exhaust systems for dust, stock, and vapor removal or conveying. These standards are a complete revision of the 1937 edition, with the exception of the section on dust, stock, and refuse conveying systems.

Submitted as a guide for the proper installation and safeguarding of these systems, the standards cover general requirements in regard to power and control, fans, ducts, protection against static electricity, and fire extinguishing apparatus. The section on systems for the removal of flammable vapors includes the design of systems, ducts, and fire extinguishing apparatus. The section devoted to dust, stock, and refuse conveying systems provides specifications for cyclone collectors or separators, vents, vaults and refuse receptacles, and small receptacles. The ventilation of kitchen cooking equipment is also covered.

Prepared by the committee on blower systems of the National Fire Protection Association, and identified as NBFU Pamphlet No. 91, these standards may be obtained from the National Board of Fire Underwriters, 85 John St., New York 7.

Outlines Design Procedure for Hospital Air Conditioning

Methods of air conditioning hospital spaces such as patients' rooms, public spaces, diagnostic and treatment rooms, operating, delivery, and anesthesia rooms, and nurseries, together with data on operating and installation costs are outlined in a paper, Hospital Air Conditioning, by W. S. Bodinus.

The author, chairman of the American Society of Refrigerating Engineers' committee on hospitals and institutions, stresses factors peculiar to this type of installation wherein rest, relaxation, and comfort of the patient are of great importance. Identified as Refrigerating Engineering Application Data Sheet 38, copies may be obtained from ASRE headquarters at 40 W. 40th St., New York City for 20 cents each.

An oak tree is a symbol of deep rooted strength that has been tested by wind and storm and time. Other trees may spring up faster. Some grow taller. Many have more spectacular coloring . . . But few produce stauncher timbers.

What has an OAK TREE got to do with an OIL BURNER "ad"?

Much as an oak tree grows, the S. T. Johnson Co. has grown from a very small and unpretentious acorn planted in 1903 . . . just two years after President McKinley's assassination.

Forty-four years have passed since we built our first oil burner. We've been building them ever since . . . building nothing else . . . building with a single-minded determination to make oil burners safer, quieter, more efficient, more economical . . . Many of the great advances in oil burner design grew out of Johnson engineering skill.

Today, technical leadership of Johnson Oil Burners is known to heating engineers the world over. And the tiny S. T. Johnson Co. that started in a one-room workshop in the far west has become a landmark in the vast oil burner industry.

Johnson Oil Burners

S. T. JOHNSON CO.
940 Arlington Ave., Oakland 8, Calif.
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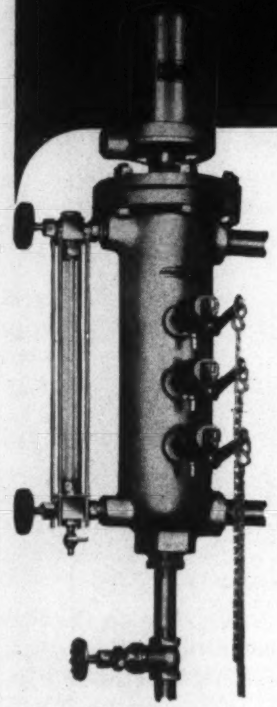
There's a Johnson Oil Burner for every heating need

NOW–Water Column and Positive Automatic Level Control in a SINGLE UNIT with MAGNETROL



• Here's the answer to a long-felt need — a new Magnetrol all-in-one-unit water column and boiler water level controller. Just check its advantages: It costs less, installed, than a separate water column and cross-connected controller. It's more reliable — no cross-connection piping to become clogged; also allows closer "following" of boiler water level changes. It reduces boiler maintenance — only one blow-down instead of two. It's easier to install. It saves space.

The float chamber in this all-in-one Magnetrol has been made longer, and has tapped outlets for gauge glass and three try-cocks — conforming fully to A.S.M.E. Code Water Column Requirements. Model W-251, illustrated, for pressures up to 250 lbs. Model W-126, pressures up to 125 lbs.

MAGNETROL MEANS GREATER SAFETY

Provides a truly fool-proof method of pump control, low water fuel cut-off and low water alarm. (High water alarm and cut-off function also available). Level changes are transmitted to the switching mechanism by magnetic action . . . *no bellows* . . . *no stuffing box* . . . *no diaphragms* . . . *no electrodes.* New "Unitary" Switching Mechanism is completely self-contained — installed or replaced as simply as changing cells in a flashlight. Switch spacing and level differential easily adjusted.

MAGNETROL STANDARD MULTI-STAGE CONTROLS

Incorporate all the notable Magnetrol features. Normally provides 2-stage control — upper stage starts and stops boiler feed pump, lower level controls low water fuel cut-off or alarm, or both. A third level stage can be added, for two-stage pump control. Model 251, pressures up to 250 lbs. Model 126, pressures up to 125 lbs.

MAGNETROL SINGLE-STAGE CONTROL

Model 249 (Pressures up to 250 lbs.) Ideal for low water cut-off and/or alarm function only, at low cost.

Write for Bulletin 147 and full information on Magnetrol Boiler Water Level Controls.

MAGNETROL, Inc.
A Division of Fred H. Schaub Engineering Co., Inc.
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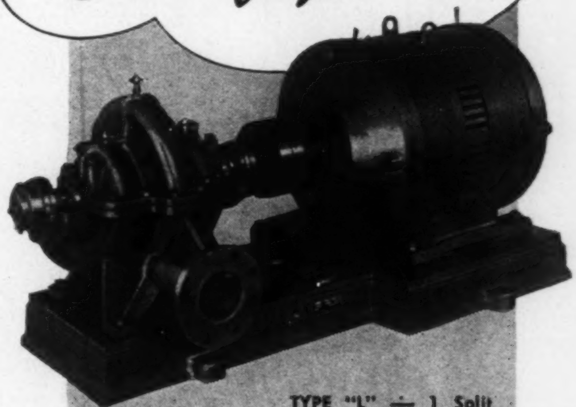
use WEINMAN *Centrifugal* PUMPS!



TYPE "L" — 1 Split Case Centrifugal Pump, direct-connected to motor. For circulation of cooling water over Condenser Towers and Atmospheric Condensers. Worn parts can be replaced without disturbing or disassembling any pipe connections.
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WEINMAN pumps are designed and engineered by Centrifugal Specialists who KNOW THE AIR CONDITIONING FIELD and have applied this knowledge to pumps to do the job more economically and to give longer trouble-free service . . . quietly . . . dependably.

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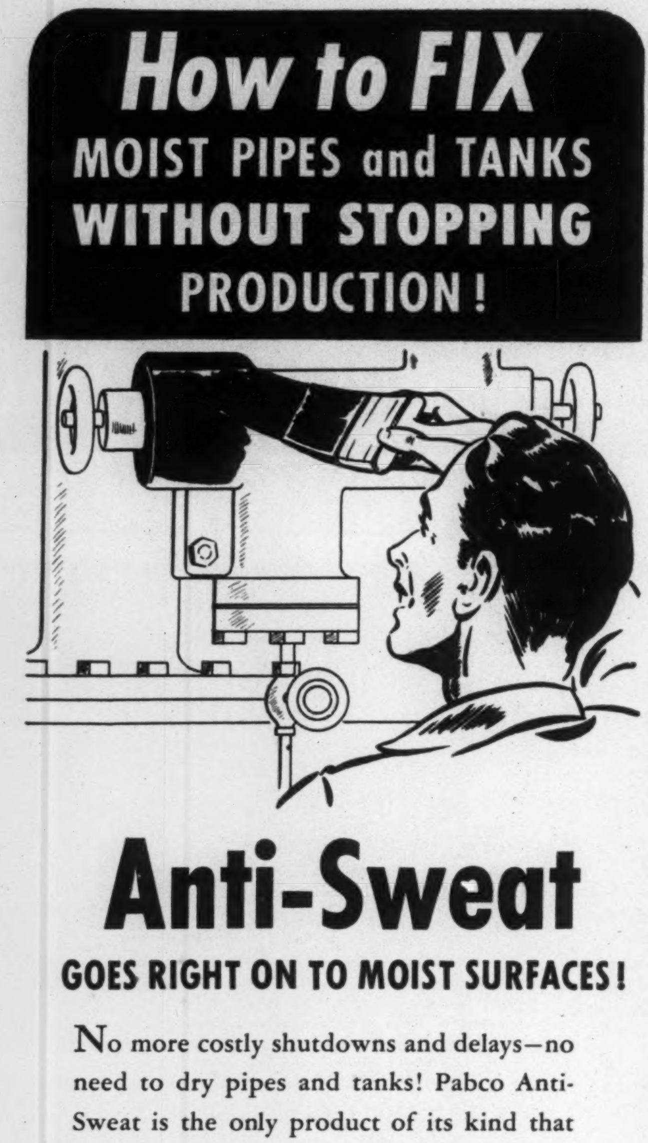

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Other Books and Reports Received

Symposium on Atmospheric Exposure Tests on Nonferrous Metals, 150 p. booklet published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Price, $2.25 for cloth binding, $1.75 for paper cover.

Describes and evaluates a wide series of atmospheric exposure tests carried out over many years on nonferrous metals and alloys, and also includes some ASTM committee B-3 reports.

The Welding of High Temperature, High Pressure Steel Valves, by V. T. Malcolm and Sidney Low, Journal of the American Welding Society, 33 W. 39th St., New York City, Vol. 26, No. 2, p. 101.

Describes the design and construction of welded bonnet valves to obtain required service life for central station use. The paper covers the design of weld bevels or joints, welding equipment, preheating, the base metal, electrodes, welding sequence, stress relieving, and quality of welds.

Directory of Member Institutions and Review of Current Research, 1947, published by the engineering college research council, American Society for Engineering Education, State University of Iowa, Iowa City. Price, $1.00 per copy.

The directory lists virtually all major colleges and universities and outlines their principal fields of research. Individual research sponsors are not named but projects reported under such sponsorship are marked with an asterisk.

The Apparent Influence of Grain Size on the High Temperature Properties of Austenitic Steels, by C. L. Clark and J. W. Freeman. Presented at the 28th annual convention of the American Society for Metals, 7301 Euclid Ave., Cleveland, Ohio. Price, 30 cents per copy.

Presents results obtained from an investigation to determine the effect in variations of grain size on the high temperature strength characteristics of austenitic steels. Four different steels were considered and their relative high temperature properties are evaluated on the basis of short time tensile, creep, and rupture tests at temperatures varying up to 1800 F.

Changes in Austenitic Chrome-Nickel Steels During Exposures at 1100 to 1700 F, by Peter Payson, C. H. Savage. Presented at the 28th annual convention of the American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio. Price, 45 cents per copy.

The study of steels of the 302, 311, 309, and 310 types, with variable silicon and with additions of nitrogen, columbium, titanium, and zirconium, shows that the formation of sigma from austenite is promoted by the presence in the steel of high percentages of chromium, silicon, and nitrogen, as well as by the additions of columbium, titanium, and zirconium. Room temperature tensile and notch impact data are given for these steels after long exposure at 1400 and 1600 F and a few results of high temperature tests are included.

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New powerful ventilator helps you improve your factory working conditions

● Where you have heat, smoke or fumes in concentrated quantities, it takes POWER to expel it fast enough to keep the atmosphere cleared for greatest comfort. It pays you to heed this requirement for better worker morale—greater efficiency and safety. Ject-O-Valve supplies concentrated force, scientifically applied, for power ventilation.

Swartwout skill in building roof ventilating equipment for over forty years is reflected in Ject-O-Valve construction: sturdy, reinforced design, correctly selected propeller type fans, convenient provision for servicing, completely weathertight under all conditions. Your plant is a better place to work in when you have Ject-O-Valve ventilation over "hot spots" or fume-producing departments. Write for details.
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Controlled **Air Circulation**
EQUIPMENT FOR EFFECTIVE ECONOMICAL
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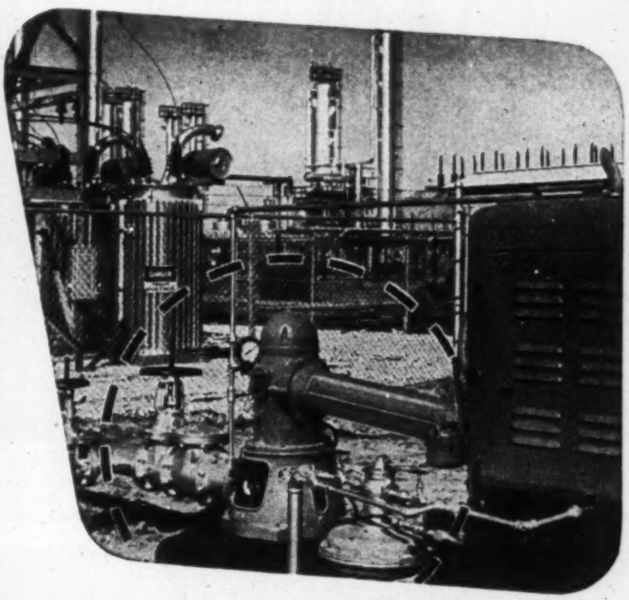

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OF THIS PICTURE

To you, the reader, the above picture is just one of hundreds of Layne Well Water Systems that are now serving oil fields, refineries and pumping stations. But to us, it is a symbol of approval by one of the world's largest and most important industries. Furthermore, this picture serves to symbolize a record of nearly seventy years of successfully matching the highest quality materials with honest craftsmanship.

Yes, we are proud of this picture—and several thousand others of Layne Well Water Systems now serving Municipalities, Railroads, Factories, Chemical Works, Packing Plants, Paper Mills and Air Conditioning and Irrigation projects.

We know the penalty of leadership in our chosen field, the flattery of imitation and the real satisfaction of serving the same customers for generations and generations. Our equipment and services are consistently higher in quality than the buyer demands — more dependable than we promise—and longer lasting than the owner expects.

If such points of merit are of more interest to you than a "special price," we can serve you with complete satisfaction. For late bulletins, catalogs, etc., address

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- **pumps** for wells, lakes, rivers, reservoirs, irrigation—or for any use where large quantities of water must be produced at low cost. Sizes range from 40 to 16,000 gallons per minute. Write for Layne Pump Catalog.

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vertical turbine pumps

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MEETINGS & CONVENTIONS

Foreign Visitors Invited to Instrument Conference

The international liaison committee of the Second Instrument Conference and Exhibit has extended invitations to engineers of all countries to attend the conference and exhibit at the Stevens hotel in Chicago, September 8-12, 1947.

Sponsors Short Course on Steam and Hot Water Heating

A three day short course on the problems of steam and hot water heating will be sponsored by the Institute of Boiler and Radiator Manufacturers and the University of Illinois, September 9, 10, and 11, at the Navy Pier branch of the university in Chicago. The program will be conducted on the shop plan and will include lectures, discussions, and design problems. Topics to be covered include heat loss through building construction, resistance to flow in pipes and fittings, factors affecting comfort, the selection and location of related equipment. Much of the subject matter will be drawn from the results obtained at the IBR research home located on the university's Urbana campus. A $15.00 tuition fee will be charged to cover the costs of books and supplies and individual living expenses will be paid by each student.

Many Sessions Planned for AGA Convention

The general plan of 29th annual convention of the American Gas Association, to be held October 6-8 in Cleveland, calls for general sessions each morning with meetings of the sections and departments in the afternoons. Anticipating housing difficulties, the association has requested that reservations be made promptly through E. C. Brennan, AGA housing secretary, 511 Terminal Tower, Cleveland 13, Ohio.

Hydraulics Conference to Be Held in Chicago

The third annual meeting of the National Conference on Industrial Hydraulics (formerly the Hydraulic Machinery Conference) will be held, October 16 and 17, at the Hotel Continental in Chicago. The conference is sponsored by Armour Research Foundation and the graduate school of Illinois Institute of Technology in cooperation with the Chicago sections of the SAE, ASCE, and ASME.

Additional information may be obtained from Dr. V. L. Streeter, Armour Research Foundation, Technology Center, Chicago 16, Ill.

AWS Members to Meet During Metal Exposition

The American Welding Society, 33 W. 39th St., New York City, will hold its annual meeting concurrently with the National Metal Congress and Exposition, to be held in Chicago, October 18 to 24.

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Paracoil

FLEXIBLE NIPPLES

THEY BEND!

- MAKE TOUGH JOBS EASY!
- SAVE TIME AND LABOR!
- REDUCE COST OF INSTALLATION!
- INCREASE HEATER CAPACITY!

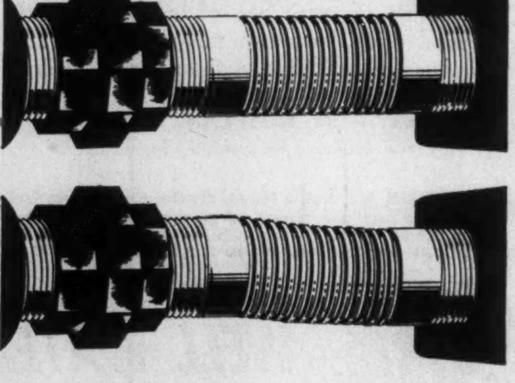
MADE IN 4 SIZES: ¾" x 3"...1" x 4"...1¼" x 4½"...1½" x 5"

"Paracoil" manufactures many types of heating and ventilating accessories—all distributed through franchised agents. Some lucrative territories are still available. If interested, write our Elizabeth office for details.

Manufactured by

DAVIS ENGINEERING CORPORATION

ELIZABETH NEW JERSEY



The grooved center section is dead soft for flexing, acting like an accordian, while the ends which have clean cut standard right hand pipe threads are hardened. Made of iron pipe size copper, the soft center section bends to your will.

The RIGHT INSULATION correctly applied NEVER GROWS OLD

Selecting the Right Insulation: Any insulation will save *some* money—but only the right insulation, correctly applied, will save the *most* money for the longest period of time. Because of its many advantages, leading refrigerating engineers have long relied on J-M Rock Cork Insulation for refrigeration service.

Correct Application: No insulation is better than the man who installs it. That's why every J-M Insulation Applicator is a skilled mechanic thoroughly trained in all phases of up-to-date application methods.

26 Years Young: J-M Rock Cork Insulation was used to insulate this 40′ x 60′ cold storage room of the Defiance Grocery Company, Defiance, Ohio, back in 1921. Because the job was *engineered right* and *applied right*, it is still providing dependable service.

If you would like to have a J-M Insulation Engineer help you with your next insulation job, write Johns-Manville, Box 290, New York 16, N. Y.

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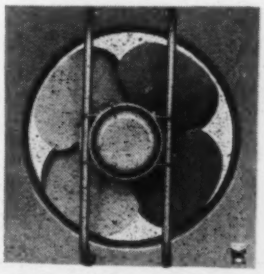
Prompt Deliveries on Peerless Exhaust Fans

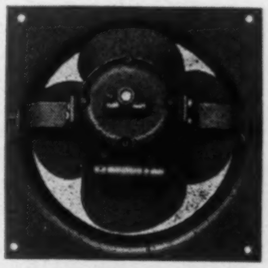
A number of sizes and models of Peerless exhaust and attic fans are now available for prompt shipment. This is your opportunity to meet your needs with fans of proven performance, attractive design and quiet operation—all carrying the famous Peerless name and powered with Peerless Motors. Send us your requirements.

DeLuxe Fans



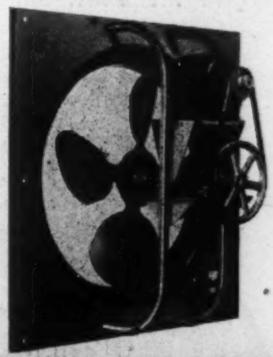
Here is an *extremely quiet*, variable speed, attractively designed fan for stores, restaurants, hotels and similar installations. Totally enclosed motors exclude dirt and moisture. Fans may be mounted vertically or horizontally. Supplied for single speed, two-speed, or three-speed operation. Finished in Buckingham grey. 16″ to 30″ sizes.

Small Ventilator Fans



These fans provide plenty of air movement for homes, small grills and offices. Motors are totally enclosed. Fan and panels finished in Buckingham grey. Sizes—10-inch 6 blade; 12- and 16-inch 4 blade; 12-inch multiblade.

Attic Fans



Powerful air movers that are economically operated and easily installed. Belt-driven by thermally protected Peerless Motors. Extremely quiet and efficient in operation. Modern design with all-metal panel finished in attractive grey. 24 to 48-inch sizes.

THE Peerless ELECTRIC CO.
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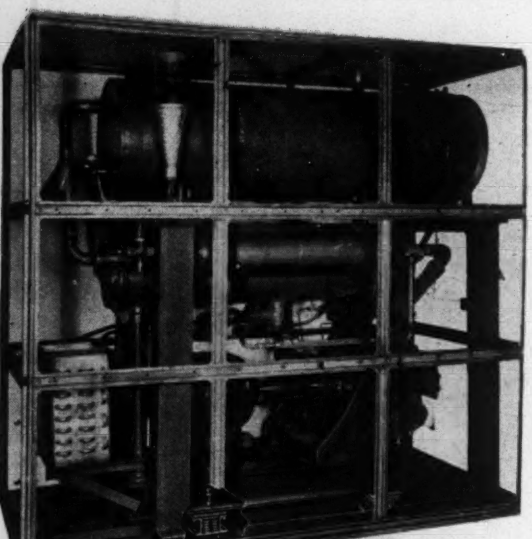

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UNCONTROLLED vibration in compressors, condensers, fans and unit conditioners, can prevent one of the main benefits of air conditioning—silent, unnoticeable operation.

And this silent operation can be obtained so easily! Standard Korfund-Engineered Vibration Control Units include the specially-developed Twin Rail Fan Base and Vibro-Isolators. Korfund utilizes steel-spring, rubber or cork materials to give the exact amount of isolation required.

Over forty-five years of experience in designing vibration control equipment enables Korfund to supply the answer to your vibration problem—and it's both economical and efficient. Write today for more details.

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Timing Motor

Accurate Dependable

Hardened Steel Shafts — operate in Babbitt Bearings bathed in oil —

THAT'S ONE REASON WHY USERS HAVE LEARNED TO EXPECT ***Lasting Accuracy*** FROM

SYNCHRON

TIMING MOTORS AND TIME MACHINES

Ask any time machine maker — any electric clock repair man — what motor outlasts all others, and he'll say "SYNCHRON". In these tiny motors, all pinions and shafts are of steel, operating against polished brass gears — for least possible wear. All bearings are genuine Babbitt, lubricated by a sealed-in supply of oil surrounding all moving parts (patented process). SYNCHRON timing motors and time machines are designed, patented, and built for dependable, trouble-free service. Write for complete engineering data.

HANSEN MANUFACTURING CO., INC.
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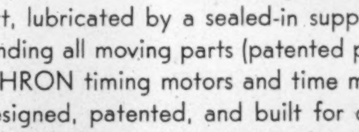

Timing Machine

Time-Tested

The meeting will be held at the Sherman hotel, and M. M. Kelly, society secretary, has issued a hotel reservation form to all members with the request that those who do not have accommodations return the filled out form to the Housing Bureau, National Metal Congress and Exposition, Chicago.

Chemical Show to Be Held for West Coast

An industrial chemical conference and display for western states and Pacific area are scheduled for the Civic Auditorium in San Francisco, Oct. 21-25. This is the first regularly scheduled Pacific Chemical Exposition and will be presented by the California section of the American Chemical Society, whose headquarters is at the Whitcomb hotel, San Francisco.

ASME Members to Meet in Atlantic City

The 1947 annual meeting of The American Society of Mechanical Engineers, 29 W. 39th St., New York City, will be held at the Chalfonte and Haddon Hall hotels, Atlantic City, December 1-5.

Some of the other meetings scheduled for the remainder of the year include:

Fall meeting, Salt Lake City, Utah, Hotel Utah, Sept. 1-4.

Industrial instruments and regulators division, Chicago, Sept. 8-9.

Petroleum mechanical engineering conference, Houston, Tex., Oct. 6-8.

Fuels division, joint meeting with the coal division of the AIMME, Cincinnati, Ohio, Oct. 20-22.

Contractors, Service Engineers to Meet During REMA Exposition

On January 27, 1948, the National Association of Refrigeration Contractors and the Refrigeration Service Engineers Society will view the 5th All-Industry Refrigeration and Air Conditioning Exposition in Cleveland. According to REMA, sole sponsor of the show which will be held from January 26-29, both the NARC and the RSES will have special events in connection with the exposition. During the week preceding the show, the service engineers will hold their 10th annual convention, and it is understood that the contractors will participate actively in the show program.

8th Heating, Ventilating, and Air Conditioning Exposition to Be a Sellout

The 8th International Heating, Ventilating, and Air Conditioning Exposition will occupy all of the available display space in Grand Central Palace, New York City, the week of February 2, 1948.

Exhibitors' response to date indicates that all space will be exhausted in advance of the opening, according to C. F. Roth of the International Exposition Co., Grand Central Palace, New York, N.Y., managers of the show.

The exposition will again be under the direct auspices of the ASHVE, and the Society's 54th annual meeting will be held concurrently.

HAYES DUCT FURNACE

STAINLESS STEEL HEAT EXCHANGER

The Hayes SED-E model (end service illustrated) is a gas fired unit designed to be installed into and become a section of a duct system, similar to heating coils. Also made in side service.

Constructed of Type 321 *Stainless* Steel. Can be installed down stream of cooling coils, making it unnecessary to drain refrigerant on the heating cycle.

May be installed in banks, for large BTU requirements.

Immediate Delivery on
14 sizes from 80,000 to 600,000 BTU input.

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